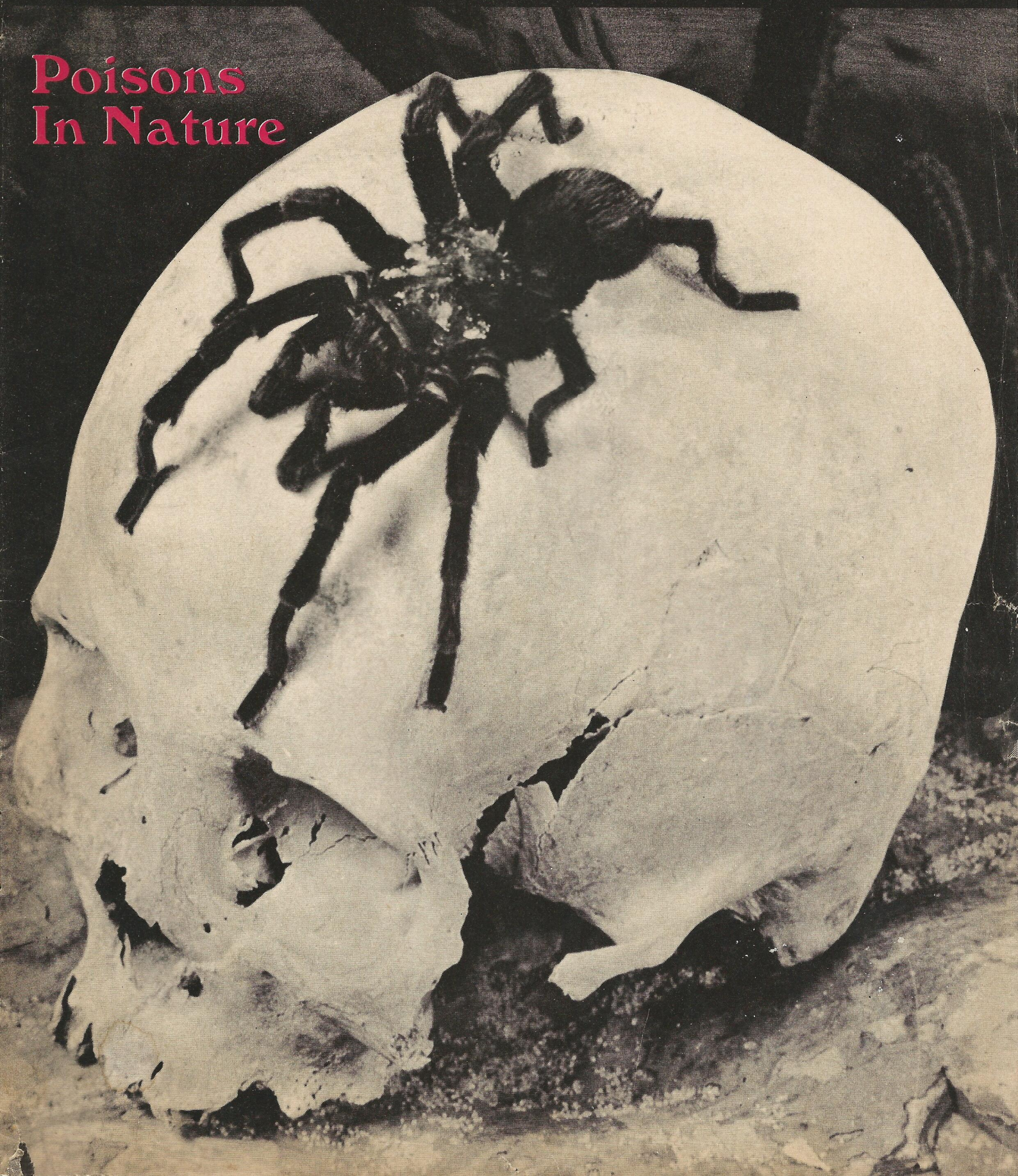
DECEMBER 14, 1967 • VOL. 22 • NO. 12 • A SCHOLASTIC MAGAZINE

SENIOR SCIENCE

For Classes in Biology, Chemistry, Physics, Earth and Space Science

Poisons In Nature



Driving with your eyes on the center line is a good way to meet new people.

Officer Stone, for example. And Judge Crain. And Court Bailiff Wiggins.

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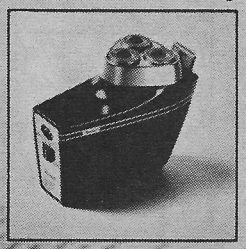

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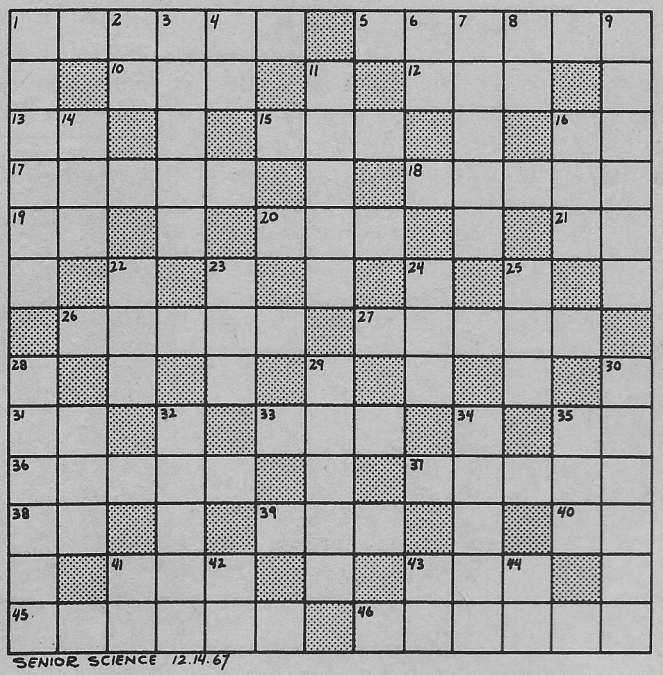
Shadow Box

By John Jefferis, Goodwell Public School, Goodwell, Okla.

★ Starred words refer to optics

Students are invited to submit original crossword puzzles for publication in *Senior Science*. Each puzzle should be built around one topic in science, such as astronomy, astronautics, botany, geology, electronics, famous scientists, etc. Maximum of 50 words, of which at least 15 must be related to the theme. For each puzzle published we will pay $10. No entry will be considered unless it includes all of the following: symmetrical puzzle design and design with answers filled in, definitions, answers on separate sheets, and a statement by the student that the puzzle is original and his own work. **Puzzles must be symmetrical.** Keep a copy, as puzzles cannot be returned. Give name, home address, school, and grade. Address: Puzzle Editor, *Senior Science*, 50 West 44th Street, New York, N. Y. 10036. Answers to this puzzle are on page **20**



ACROSS

* 1. Devices for separating light rays.
* 5. Invented incandescent light bulb.
10. Chimpanzee.
12. Interest *(abbr.)*.
13. Indefinite article.
15. Female swine.
16. Bromine *(chem. sym.)*.
17. Observes with care.
18. Broom of twigs.
19. County *(abbr.)*.
*20. Single line of light.
21. Father *(colloq.)*.
*26. A complete shadow, within which no light is received from a given source.
*27. Light is emitted in this form *(pl.)*.
31. Eastbound *(abbr.)*.
*33. Past participle of *light*.
35. Exclamation.
36. Averages.
*37. Combining form meaning *light*.
38. Cobalt *(chem. sym.)*.
39. Doctor of philosophy.
40. Noun suffix, forms diminutives.
41. The whole time of a being's existence.
43. Female sheep.
*45. Units of light.
46. Type of gas burner used in labs.

DOWN

* 1. German physicist, formulator of the quantum theory.
2. One of the States in the "Corn Belt." *(abbr.)*
* 3. Rate of motion.
4. Personal pronoun.
6. Combining form meaning *twice*.
* 7. Measure of refracting power: refractive _____.
8. Street *(abbr.)*.
* 9. Perpendicular.
*11. Of or pertaining to a focus.
14. Negative adverbial particle.
16. A style of jazz.
22. Oklahoma Military Academy *(abbr.)*.
23. They exist.
*24. Statement of scientific fact.
25. Look.
*28. Narrow beam of light.
*29. Visible energy.
*30. A quantum of radiant energy.
*32. Optical counterpart of an object.
34. Displayed.
35. Consumed.
41. Before noon.
42. Prefix meaning *in*.
43. Europium *(chem. sym.)*.
44. Eldest son *(abbr.)*.

ANSWERS TO BRAIN TEASERS
(see page 19)

Short Cutting

A twelve-foot pole is 144 inches long. One hundred forty-four inches divided into eight-inch sections will yield 18 pieces. Seventeen cuts will be required to produce the 18 pieces. Thus, the job will take 17 minutes.

Read Aloud

Did the repeated words in the triangles catch you? What does the fact that most people skip these repetitions suggest about the way we read? Would a beginning reader in the first grade be as likely to make the same mistake?

Current Problem

If we can determine how long it took the log to float one mile, we will know the speed of the current. The man rowing downstream overtook the log at the same rate that he departed from it. This occurred because the current had a constant and equal effect on both the log and the boat during the whole time. Thus, it must have taken one half-hour for him to overtake the log after he turned the boat around. Accordingly, the log traveled one mile in one hour. The current was moving at one mile an hour.

Editor's Choice

Three miles an hour. If you missed it, can you figure out why?

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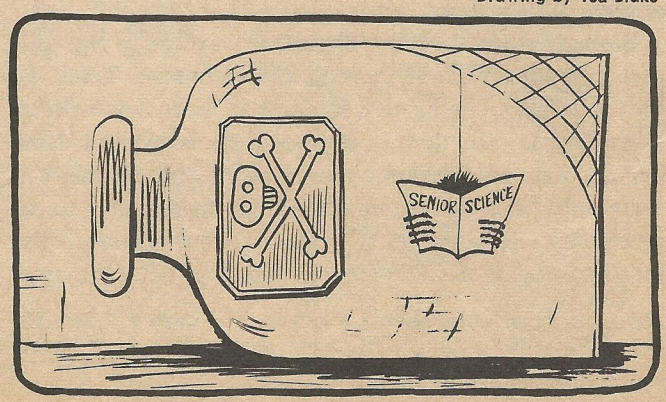
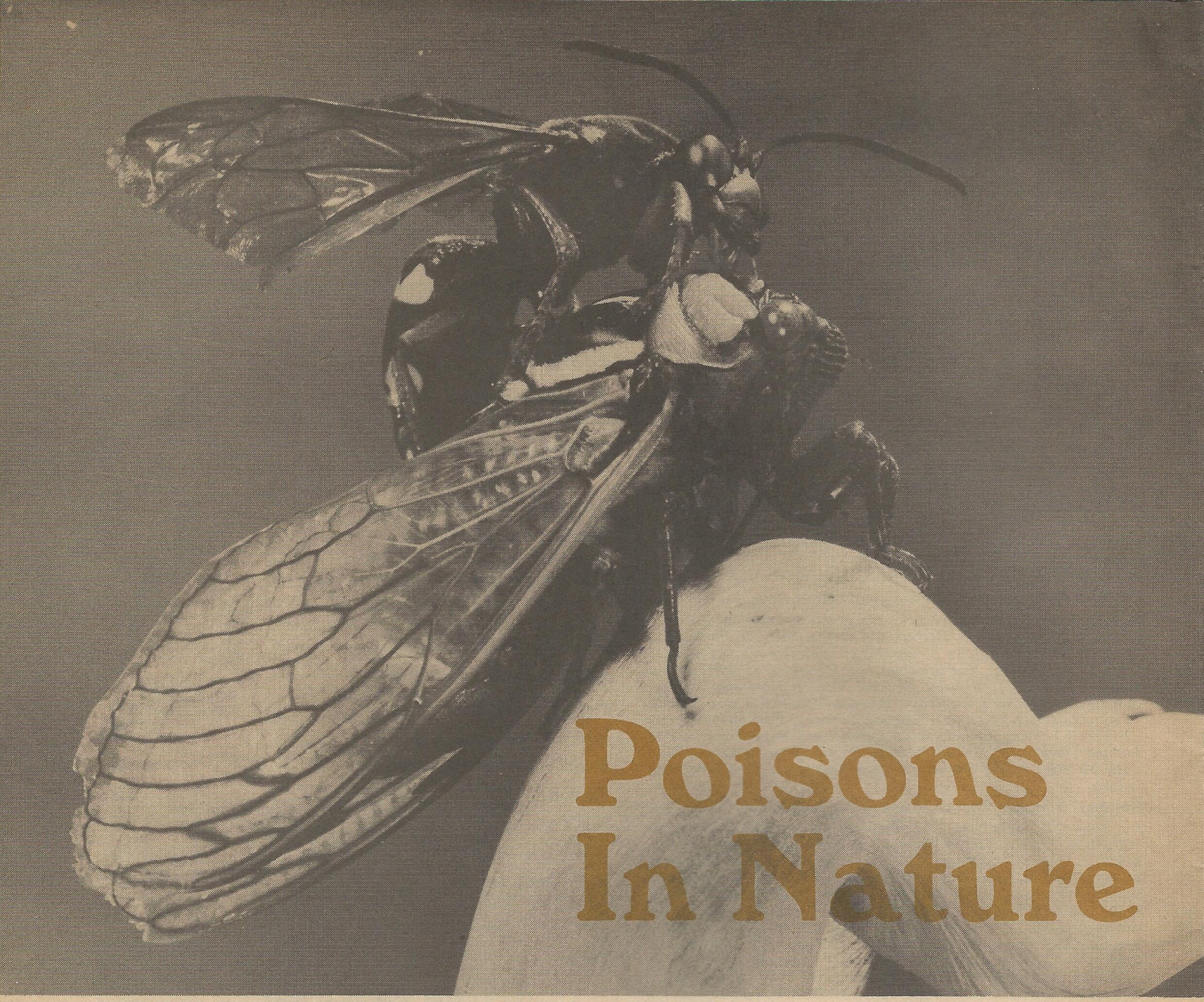
Cover photo: Kenneth Bobrowsky

Our Front Cover

Our fine furry friend this week is a tarantula—a venomous spider found in the deserts of the American southwest, among other places. Although its poison is not really so dangerous as our picture might suggest, its bite can be very painful to man. How widespread are poisons in nature? What part do they play in the lives of animals? For the answers, read the article beginning on page 4.

Drawing by Ted Blake





Poisons In Nature

Annan Photo Features

Scientists find practice of chemical warfare is widespread in animal kingdom.

THE GIANT sea cucumber, the duck-billed platypus, the marine toad, the termite, the bombardier beetle, the jellyfish, the sea anemone, the digger wasp, the gila monster, the stonefish, the scorpion, the coral snake – all have something in common. Each is a past master of the art of chemical warfare – warfare conducted with poisons.

Biologists are studying chemical warfare in the animal kingdom with increasing astonishment. Truth is, they say, that chemical weaponry is more widespread in the animal kingdom than previously suspected. New evidence shows that poisons are employed by many a seemingly harmless organism. As this evidence mounts, researchers gain new insights into *animal ecology* – the relations among living creatures and their environments.

Above: A digger wasp attacks a cicada. The wasp will paralyze the cicada with its sting. Cicada becomes food for wasp larvae.

Today, researchers believe that chemical warfare may be one of the fundamental mechanisms by which the ecology of many regions is regulated.

For an example, let's examine the unfolding of events in a certain patch of Arizona desert land. As the late afternoon sun sinks toward the horizon and long shadows reach across the sands, a hungry tarantula – a fat, furry spider – creeps from its burrow on the desert floor.

Nearby chirps a cricket. The cricket hops about seeking bits of plant matter for its supper. It lands nearer and nearer to the hairy spider. When the cricket brushes against the spider's leg, the tarantula jerks into action. Its heavy fangs crunch into the cricket, paralyzing it with venom.

The cricket, which feeds upon grasses, has become a meal for the predatory tarantula. In the drylands of the

southwestern United States and Mexico, tarantulas destroy untold numbers of crickets every day. Thanks partly to the tarantula's poison, then, the cricket population is kept from overcrowding the land.

But the land is not overrun with tarantulas, either. Why not? A tarantula never survives combat with its natural mortal enemy – the digger wasp, *Pepsis*. Inevitably, when tarantula and digger wasp meet, the spider ends up completely paralyzed.

The clash of these two foes was studied in the laboratory and in the field by the late Dr. Alexander Petrunkevitch, an expert on insects and spiders. Dr. Petrunkevitch, who died in 1964, was a professor at Yale University.

Dr. Petrunkevitch began by putting a cricket into a cage with a hungry tarantula. He expected the tarantula to eat the cricket immediately. To his surprise, the spider ignored the cricket. Only when the cricket brushed against the spider's hairy legs did the spider devour it. Conclusion? The spider was almost completely deaf and blind.

Next, the professor poked the fat body of the spider with a pencil. The tarantula moved off slowly for a distance, then stopped. When he blew on the spider, it jumped sideways. On the basis of these reactions, he concluded that almost all the spider's reactions are guided by the way it is *touched*. Its extraordinary sense of touch makes up for its deafness and poor vision. And, amazingly, the digger wasp exploits the tarantula's complete dependence on touch to poison it.

The diet of adult wasps is nectar. But wasp larvae need animal food. So each time the female wasp lays an egg she must provide it with a tarantula – alive, but paralyzed. She attaches the egg to the spider with a sticky secretion. When the egg hatches, the wasp larva begins gnawing on the tarantula. The larva dines on the tarantula until the larva grows into an adult wasp.

Dr. Petrunkevitch saw that when a female *Pepsis* spots a tarantula, it lands beside it. First it feels the spider all over with its antennae to identify it. While doing this, the wasp masks the light touch of its antennae by pressing against the spider's body. Instead of lashing out, the spider only moves away a little, just as it does when nudged with a pencil.

Satisfied that the spider is a tarantula, the wasp moves off a few inches to dig the tarantula's grave. Working quickly, the wasp scoops out a hole eight to ten inches deep. Every few seconds, it pops out of the hole to make sure the spider is still there.

The grave finished, the wasp returns to the spider. With stinger outthrust, it slides under the tarantula like a mechanic working under a car. It searches for the joint between the spider's leg and body – the only place where it can penetrate the spider's horny exoskeleton. The spider simply sits there, unaware.

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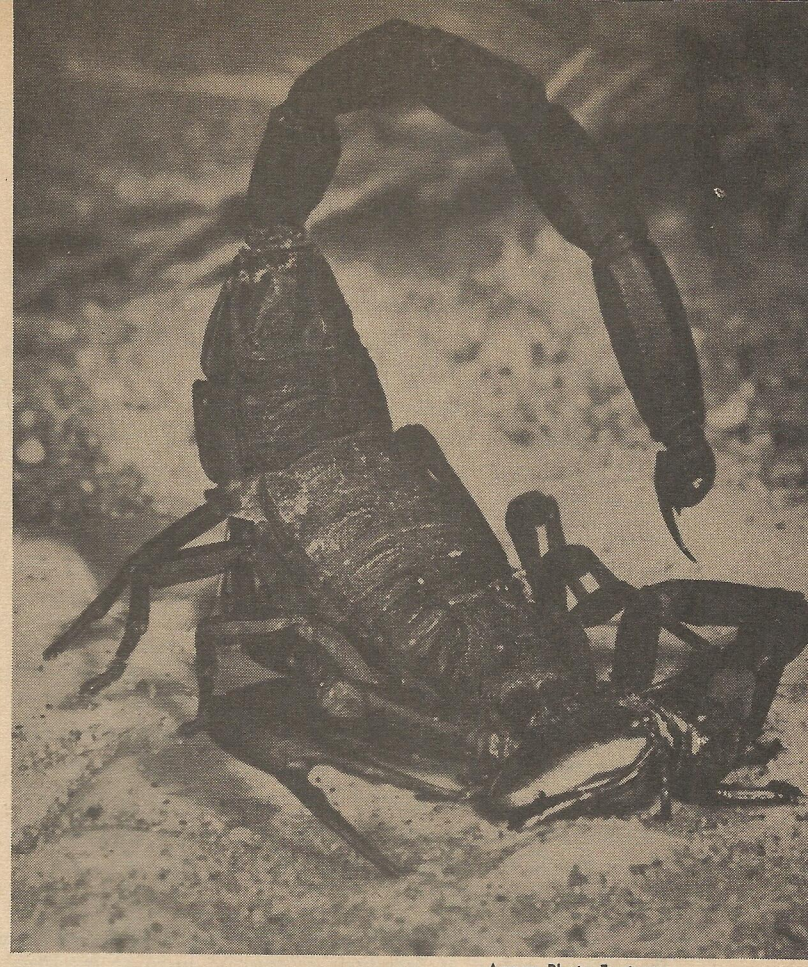


Annan Photo Features

Mealtime in the desert: A scorpion has injected venom into a beetle, with the deadly sting at the end of its whiplash tail.

The fangs of the diamondback rattlesnake are seen in the striking position. In the closeup, a drop of venom clings to the fang. Rattler's special salivary gland manufactures venom.

Bucky Reeves from National Audubon Society Annan Photo Features

Poisons in Nature *continued*

Finding the correct spot with its stinger, the digger wasp grabs the tarantula's leg with its jaws. Now the spider moves into action – but too late. The entangled pair roll over and over. But the end is always the same. The spider falls paralyzed on its back. The wasp drags it to the hole, lays an egg on the body, fills in the hole carefully, and flies away.

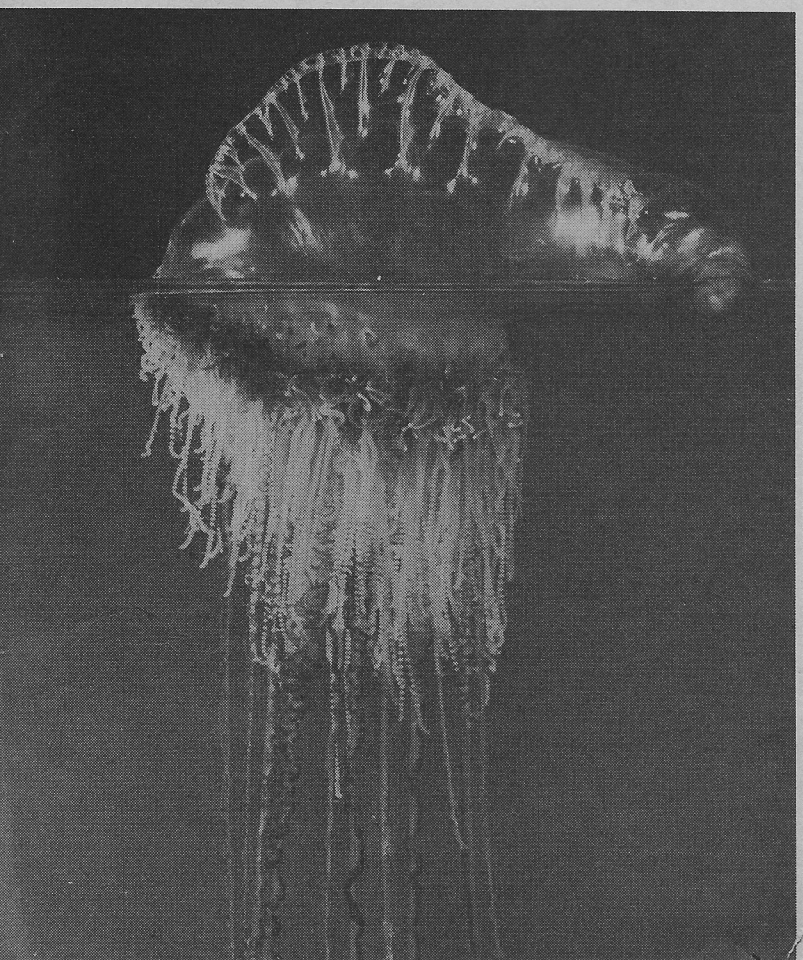
Thus wasps feed on, and help control, the tarantula population, which in turn helps control the cricket population. Digger wasps also prey on locusts and caterpillars to stock the larder for their young. It's easy enough to see that these several populations of insects keep one another pretty much in check. It's also clear that the key to the ecology of these creatures lies in their ability to practice chemical warfare.

Locusts, cicadas, crickets, and grasshoppers are among the most potentially damaging of insects from man's point of view. The destruction of crops caused by locusts, for instance, is legendary. Thus man can be grateful that wasps and tarantulas are on the scene.

Another, non-insect, poisonous creature helps hold down the world insect population: the marine toad of Central America.

This fat brown amphibian catches insects by means of its sticky tongue. It "shoots" its tongue only at moving targets. Once an insect is stuck on the tongue, the toad hauls it in and has a feast.

Adult Portuguese Man-of-War is free-swimming colony of specialized cells, including poisonous tentacles that catch food fish.



Where does the toad's poison come in? Actually, the poisonous marine toad employs its chemical weaponry for its own defense. A predator, say a coyote or a dog, that bites into the toad gets a dose of a very powerful, foul-tasting poison from glandular sacs alongside the marine toad's throat.

Most predators will spit the toad out as soon as they taste its venom. Any predator that has survived an unsavory experience with the marine toad henceforth gives other toads a wide berth. Thus, even though an individual toad may be killed from time to time by an inexperienced predator, the species as a whole is generally shunned by hungry carnivores.

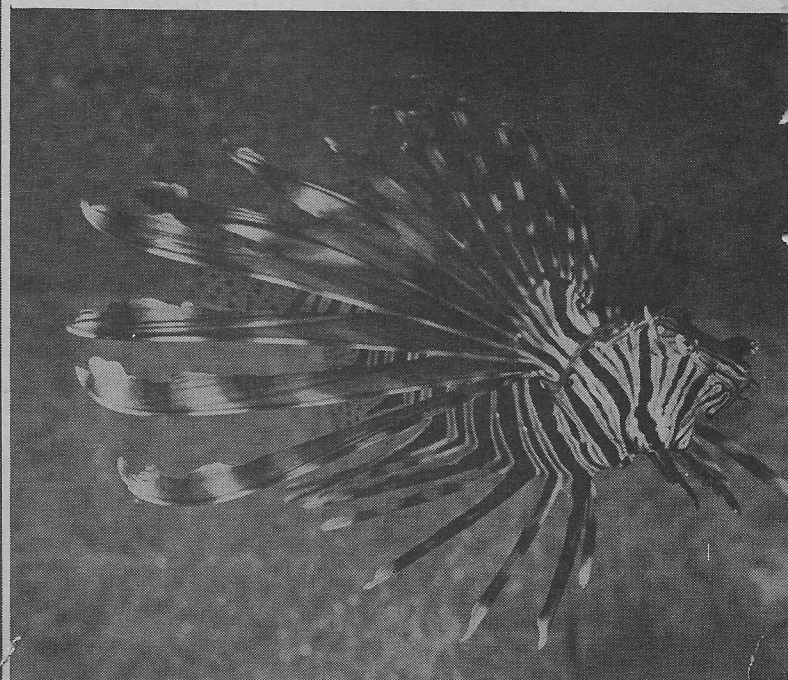
Many another species uses poison for defense rather than offense. Birds, for instance, devour caterpillars, moths, and butterflies. Scientists find that the best defense these fragile insects possess just happens to be noxious chemicals.

Dr. Alexander B. Klots of the American Museum of Natural History is an expert on butterflies and moths. He writes that the bright markings of many moths and butterflies actually serve to *attract* the attention of birds.

How could it profit a helpless creature to attract the attention of its natural enemies? Many of these brightly marked insects are protected by chemical repellents and poisonous secretions. "Some moths," Dr. Klotz reports, "secrete hydrocyanic acid, one of the most poisonous of all compounds to most forms of life. Their showy, distinctive appearance serves as an easily remembered warning of inedibility."

Do such "poison warnings" work? A German researcher, Hans Mühlmann, once painted red rings on some mealworms and then dipped them into a very distasteful chemical. Next, he offered the brightly

The scorpion fish preys upon other fish in the waters of the Indian and Pacific oceans. It has poisonous stings in its fins.



marked worms to birds. At first, the birds jumped right in and began eating the worms. But as soon as they got a taste of the noxious chemical, they backed off. Thereafter, these birds refused to eat any mealworms or caterpillars with similar markings. Scientists suspect that many a frail larva or moth owes its survival to similar danger notices that have evolved as protective adaptations in nature.

Moreover, the evidence suggests that many *nonpoisonous* species mimic the coloration of toxic relatives.

The North American monarch and viceroy butterflies are good examples. The distinctively marked monarch secretes a chemical that is noxious to birds. The viceroy, which has no chemical defenses, so closely resembles the monarch that birds generally reject it as food, too. Not that the viceroy consciously set out to imitate the monarch. Probably, those viceroys that most closely resembled monarchs survived to transmit their markings to offspring, while the others were killed off. Today the two species are a perfect "mimetic pair." Dr. Klotz points out that thousands of mimetic butterfly pairs exist in the tropics.

The nonpoisonous *coral king* and *scarlet* snakes closely resemble the lethal coral snake and live in the same environment, the southeastern United States. What advantages might the relatively harmless coral king and scarlet snakes gain from looking like the deadly coral?

Recently, two Cornell University researchers, Dr. Thomas Eisner, a biologist, and Dr. Jerrold Meinwald, a chemist, reported on a far-ranging study of chemical warfare in the animal kingdom. Many previous studies had concentrated on well-known phenomena, such as the poisonous secretions of sea cucumbers, the deadly spines of the stonefish, the stinging tentacles of some jellyfish, and the venomous fangs of rattlesnakes. The Cornell researchers concentrated on the defensive secretions of *arthropods* — insects, millipedes, and their relatives.

Predators, they report, learn to shy away from most obnoxious insects. The "walking stick," for instance, ejects an obnoxious chemical spray. Blue jays exposed to the chemical barrage refuse to get near the insects

Continued on next page

Sea nettle may look like a bridal veil adrift in the deep, but its ruffled tentacles deliver a powerful paralyzing sting.

Sea anemone has many poisonous "arms." But immune file fish usually lingers nearby for protection against larger predators.

again – even when weeks elapse between encounters.

Obnoxious insects also have "mimics." For instance, certain beetles do a headstand when approached by predators such as ants or toads. When a predator draws near, the beetle discharges a spray from its elevated rear end. A predatory ant may be overcome by the spray. If a toad gets a taste, it withdraws at once. Certain other beetles, though they lack the glands to make the poison, mimic the headstand behavior. The mere sight of a beetle going into the headstand usually drives away a predator!

But, write Dr. Meinwald and Dr. Eisner, "Some predators overcome their prey through sheer persistence. In laboratory tests, grasshopper mice relentlessly pursued whip scorpions and, although temporarily deterred by each discharge, eventually subdued their quarry. Grasshopper mice feed on certain beetles by holding them upright in their front paws, while jamming them butt-end down into the earth; the secretion that is ejected from glands that open at the rear of the beetles' abdomen is harmlessly expended in the soil."

The researchers found that defensive chemical sprays sometimes serve more than one purpose. Certain soldier termites studied by scientists have a pointed "nozzle" from which they spew a defensive spray. The secretion is aimed at insects, small reptiles, or mammals that break into the termites' nest. This spray can rapidly incapacitate most invaders. Also, say the researchers, "it acts as an 'alarm' substance, alerting additional soldiers to the state of emergency and inducing them to discharge spray toward the intruder."

Dr. Meinwald and Dr. Eisner wondered how animals could produce deadly poisons and store them without killing themselves. They put the question this way: "How do living cells make poisons without poisoning themselves?"

The scientists point out that the millipede *Apheloria* produces *hydrogen cyanide gas,* a killer if there ever was one! How does the millipede survive its own deadly poison? Laboratory dissection reveals that the production of the gas involves two storage chambers. In the larger compartment, the millipede "stockpiles" a compound called *mandelonitrile* – a stabile, nontoxic combination of benzaldehyde and hydrogen cyanide. The millipede's second storage compartment contains an enzyme that can break down the mandelonitrile, releasing the lethal gas!

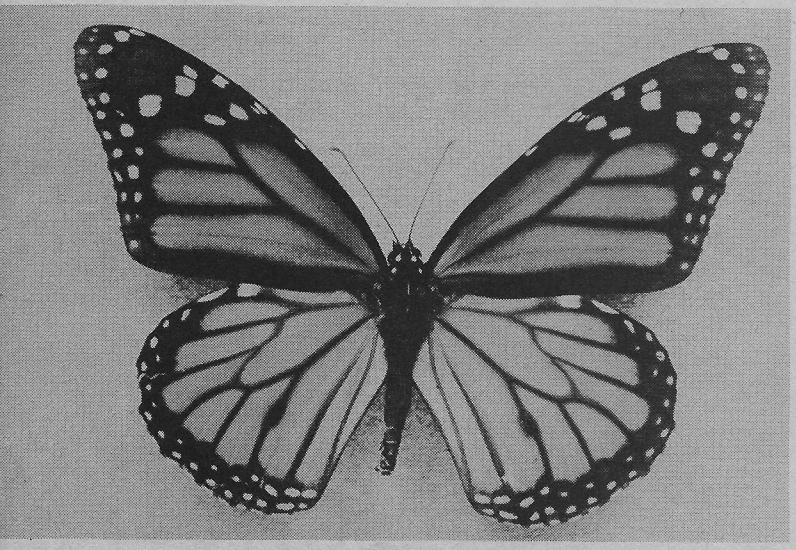
Say the researchers, "A tight valve ordinarily blocks the tubular connection between the compartments, but at the moment of discharge – which occurs by compression of the larger compartment – the valve is opened by a special muscle, and the contents of the two compartments are mixed and ejected through the single outer opening of the gland. Hydrogen cyanide emanates as a gas from the discharged mixture. Thus the final step in the production of the poison occurs, not inside the living gland cells, but outside them."

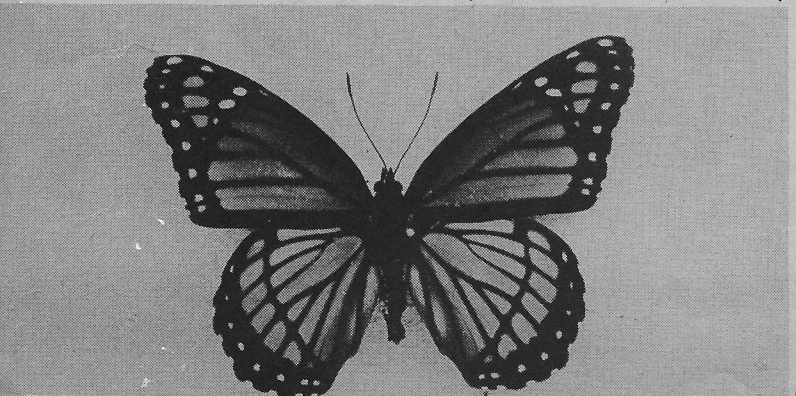
Studies show that a similar mechanism permits the bombardier beetle to manufacture and eject its lethal secretion containing poisonous compounds known as quinones. In most animals, however, the scientists believe, the deadly poisons are actually stored in their lethal form. How? The chambers in which storage is accomplished are lined with a special membrane that apparently insulates the animal from the poison.

On these pages are shown a number of poisonous animals, including some not discussed in this article. Indeed, nature's roster of chemical warriors is so extensive that, if poisonous plants were included, we could not possibly list even all the *names* of toxic or "mimetic" species on these pages! One group of plants, known as *cyanogenic plants,* for example, emits cyanide gas from the stems and leaves where feeding insects bite into them.

Scientists have only begun to crack the surface in their studies of the role of toxic chemicals in plant and animal ecology. Research is continuing – not just to increase man's scientific understanding of the ecology of poisons. Numerous chemicals identified in such organisms promise new drugs that may one day save human lives.

– JOHN SPEICHER





Toxic monarch (above) and nontoxic viceroy (below) butterflies are a typical "mimetic pair" found in nature. Viceroy's resemblance to toxic monarch offers protection against preying birds.

Courtesy American Museum of Natural History

THE DEEP FREEZE— ABSOLUTE ZERO

LET'S take a journey into cold. Let's travel down the thermometer. Past the chill of an autumn wind. Past the point where rain freezes. Past the white death of the North Pole. Past the awesome cold of outer space.

How low can we go? Is there a limit to cold?

Yes. The limit is absolute zero — the lowest temperature matter can reach.

But there seems to be no limit to how *hot* something can get. We can make an icicle as hot as the sun's surface. The interiors of stars are much hotter than that. And we know of no reason why things could not be made hotter indefinitely.

Why should there be a bottom to the range of hot-cold, but no top?

To find out, we'll have to start with what heat really is. The first clear idea of its nature was put forth in 1798 by Benjamin Thomson. He denied that heat was some sort of special fluid, as had been claimed by many scientists previously. Instead, he thought, heat was really a form of energy related to motion.

Many experiments in the 19th century confirmed Thomson's theory. They showed that a pail of water could be made warmer, for example, by whirling a paddle in it.

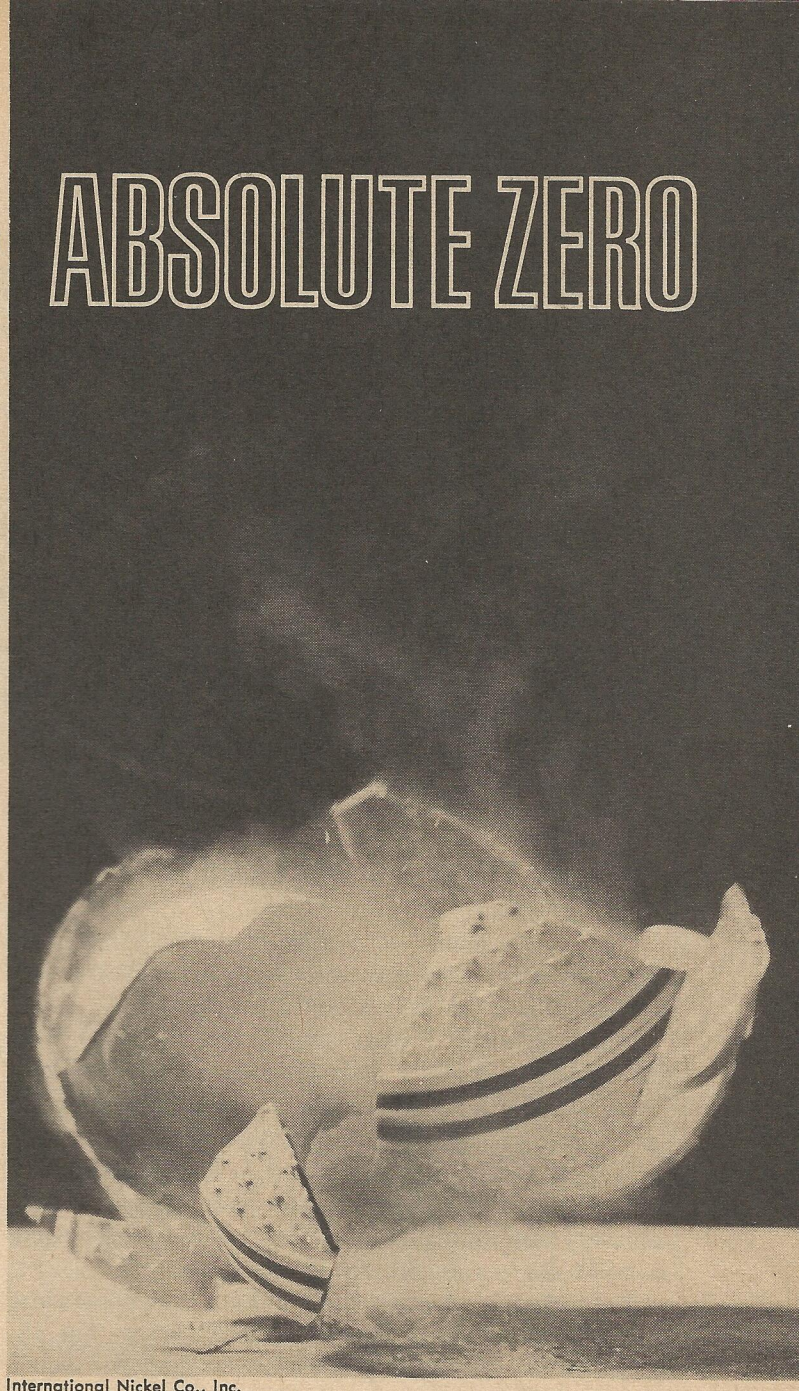
But a glowing ingot of iron may be perfectly stationary and very hot at the same time. Where is the motion here? Inside. Although the ingot seems motionless, the atoms that compose it are vibrating ceaselessly. And it is this atomic (or sometimes molecular) motion that we refer to when we speak of the "heat" of a body.

When we heat something, we jog its atoms or molecules into faster motion. When we cool it, we slow them down. The heat of an object is thus the total *kinetic energy* (the energy of motion) of the particles that compose it.

This *kinetic theory* of heat also makes it easier to understand the relation between heat and temperature. When we measure temperature to find out how hot something is, we are really measuring the average kinetic energy of its moving particles. Now we can see why one object can be a lot hotter than another — have a higher temperature — and still have much less heat!

When Molecules Slow Down

Does this seem confusing to you? Then compare a pot of boiling water to Lake Michigan. The pot of water is so hot that it could scald you. Lake Michigan is cool enough to swim in. Yet it is obvious that Lake Michigan contains vastly more heat than a pot of water — enough, in fact, to heat the air over several states. The apparent paradox is explained simply by kinetic theory.



International Nickel Co., Inc.

After being bathed in liquid nitrogen at –320°F, this rubber ball is not very bouncy. The supercold rubber shatters like glass.

The total kinetic energy of the lake is so much higher because it contains so many more molecules than the pot of water, even though the average energy of its individual molecules — its temperature — is much lower.

Perhaps you have an inkling, now, of why an object's temperature can go no lower than absolute zero.

If you kept slowing down an object's atoms and molecules — cooling it off — you would eventually reach the point at which they come to a complete standstill. No motion: no heat. And the temperature at this point? Zero. Absolute zero is the end of the line for heat.

On the other hand, the pace of atoms and molecules can be speeded up indefinitely, as long as the required amount of energy is supplied. And so, as far as is known, temperature has no upper limit.

Continued on next page

Westinghouse Broadcasting Corp.

A scientist, holding aloft a chunk of solid nitrogen, demonstrates how rapidly it warms and changes states. Solid changes to liquid, which turns to gas, just as it drips to table top.

The Deep Freeze—Absolute Zero

continued

The first scientist to realize that this concept of absolute zero followed directly from the kinetic theory of heat was Lord Kelvin, a British physicist.

About a hundred years ago, Kelvin proposed what he called the *absolute scale of temperature.* This scale started at absolute zero and went on up indefinitely. To be useful, of course, a temperature scale must have numerical values. Kelvin decided to let one degree on his scale equal one degree on the centigrade scale. And absolute zero on his scale — 0 degrees K — he set equal to –273 degrees on the centigrade scale.

But in Kelvin's day, scentists had not even come close to this fantastic cold. How did Kelvin know that absolute zero — the full-stop of molecular motion — would occur at just this temperature? Surely he did not pick the number 273 out of a hat?

Although Kelvin could not really know when absolute zero would be reached, he could *predict* it. How? On the basis of an experiment that had been performed about 50 years before, by two Frenchmen.

First Jacques Charles, and two years later Joseph Gay-Lussac, carefully measured the expansion and contraction of gases as they were heated and cooled. Each scientist found that the volume of a gas at 0°C decreased by 1/273 for every centigrade degree of cooling.

Fifty years later, Kelvin used this result to estimate absolute zero. He concluded that if it were possible to begin with a gas at 0°C and then reduce its temperature 273 centigrade degrees, its volume would shrink by 273/273. In other words, it would disappear!

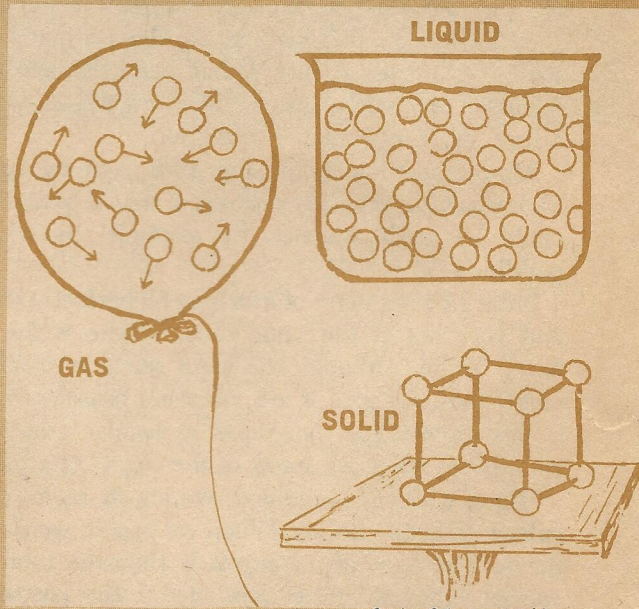
This vanishing point, reasoned Kelvin, must be the one at which the gas molecules would stop their erratic motion, and therefore stop taking up space. And this point is absolute zero.

Does a gas really follow this rule, called Charles' Law, as its temperature approaches absolute zero? Not quite. For this law is like the other gas laws. (Boyle's Law, which relates pressure and volume, is one.) It is based on an imaginary but scientifically useful model of gas. This model is known as an *ideal gas.* Why ideal? Because it behaves the way a real gas would if we could ignore some of the properties that real gases possess.

For example, the gas laws assume that the size of the gas molecules is negligible. This is a perfectly reasonable assumption to make at normal temperatures and volumes. The molecules of the gas are so far apart that their diameters are infinitesimal by comparison.

What happens, though, if you lower the gas temperature radically, or squeeze it into a very small space? Then the gas molecules bump into one another with much greater frequency, and their size is no longer unimportant.

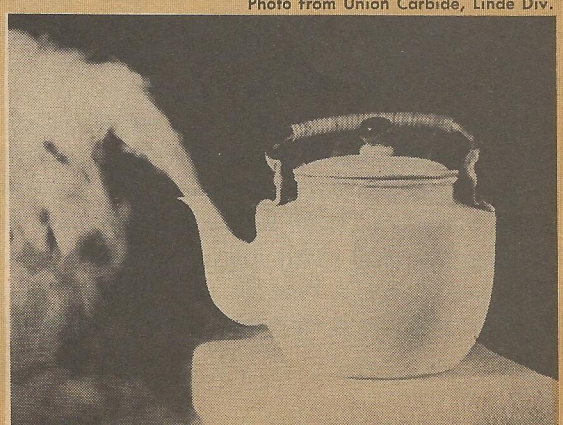
Suppose you and a dozen or so friends were dancing in a huge ballroom. The behavior of the dancing couples



Senior Science graphic

Molecules of gas zigzag about like swarm of angry bees. Diagram above shows how molecules begin to bind together as temperature drops. As liquid, the molecules hold together but slide over each other. When temperature drops further, molecules are fixed in crystal framework. Liquid nitrogen in kettle (bottom) turns into gas at –320°F. Heat comes from a block of dry ice, comparatively "hot" at –109°F.

Photo from Union Carbide, Linde Div.



would be very little affected by their size. But what if you all tried to jam into the kitchen?

Another assumption made about an ideal gas is that its molecules do not attract one another. In a real gas, there *are* rather feeble forces between the molecules.

Because of these properties, real gases don't behave the way the ideal gas model predicts. At least not under extreme conditions. Real gases *liquefy* when they are cooled, often not until very low temperatures are reached. Helium liquefies at only a few degrees above absolute zero.

Have scientists been able to get any closer to absolute zero than the freezing point of helium? Yes. Physicists at Oxford University in England have come within a few millionths of a degree! But most scientists believe that absolute zero is like the pot of gold at the end of the rainbow — tantalizingly close . . . impossible to achieve.

They postulate that the last quiver of motion within any bit of matter can never be quite stilled. Absolute zero can be *approached* as closely as we wish, but never *reached.*

The Freezing World of Cryogenics

The concepts surrounding absolute zero are extremely important to modern physics. But we have other reasons for being interested in low temperatures.

Like heat, supercold has been put to work. A whole industry has grown up around *cryogenics* — the science and technology of ultra-low temperatures. Cryogenics (the word stems from the Greek word for "cold") contributes to medicine, heavy industry, space flight, and even food processing. Here are a few examples of these contributions:

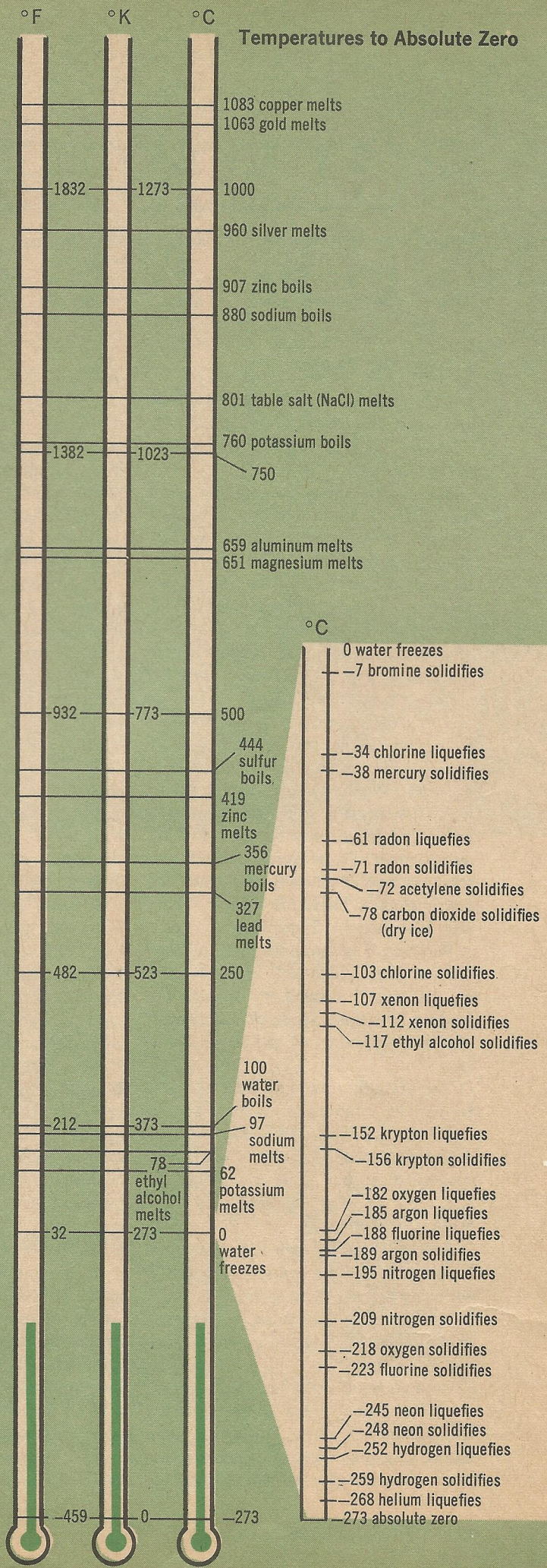
▸Physicians have successfully operated on patients with diseased brains by freezing the affected cells with liquid nitrogen. The freezing is almost instantaneous, leaves the rest of the brain intact, and permits the surgeon to work very rapidly. Other physicians have performed delicate eye operations and destroyed cancerous growths with cold probes — instruments that direct a flow of ultracold liquid gas to a tiny area.

▸Liquid hydrogen and liquid oxygen fuel many of our mighty rockets.

▸Fruits and vegetables can be frozen so fast with liquefied gases that ice crystals don't have time to form within them. In food frozen by ordinary means, ice crystals develop within the plant cells. When the fruit or vegetable thaws, the ice melts and ruptures the cell wall. The result is "mushiness" and loss of flavor. But a tomato dipped in liquid nitrogen will freeze rock-hard in seconds, stay that way for a month, and be undamaged when it is thawed.

▸Recent experiments have revealed what may be the most important use yet of cryogenics. Human blood normally deteriorates in a few weeks under normal refrigeration. But it apparently can be kept indefinitely at very low temperatures. Our ever-growing need for emergency reserves of blood may be met at last.

— Raphael Gatti



SCIENCE IN THE NEWS

Eye on the Moon

The fourth successful moon-scanning spacecraft, Surveyor 6, is now transmitting data from a point dead center on the moon.

Surveyor 6 landed on a sloping hill in the *Sinus Medii* (central bay) section of the moon. It is in camera range of long, narrow clefts in the moon's surface, a region unlike the areas two previous spacecraft reported from.

Surveyor 6 was sent to the center of this central lunar sea to investigate the area as a possible landing place for manned moon expeditions. Scientists report that the terrain around Surveyor 6 is much rougher than the areas where other spacecraft have landed. They say the Sinus Medii Bay is heavily pitted with craters and trenches. It is 400 miles west of Surveyor 5, which is lying on the moon's Sea of Tranquillity. Scientists are now trying to reactivate the instruments on board Surveyor 5, which was launched in September.

Surveyor 6 is equipped with a lunar soil analyzer which will transmit data on the topsoil around the spacecraft's landing site. The spacecraft has already sent back pictures of the local sandy area.

The seventh, and final, Surveyor will be sent to a mountainous area on the moon in January. With Surveyor 6, American scientists now have sent spacecraft to four lunar sea areas.

Gills for Man?

According to one scientist, man will be breathing under water – like fish – within five years. The scientist is Captain George Bond, principal investigator of the U.S. Navy's Man-in-the-Sea program.

Captain Bond bases his prediction on work being done by a Dutch scientist, Dr. Johannes Kylstra. Dr. Kylstra has found that the lungs of mammals can work like the gills of fish, to extract oxygen from water. Experimental mice, rats, and dogs have actually breathed the dissolved oxygen in water. One mouse survived under water for 18 hours. Captain Bond thinks that research will find a way to enable man's lungs to function in the same way.

Fighting Blood Clots

Blood clots in the human circulatory system are log jams that can kill or injure. They can be the immediate cause of such troubles as heart attacks, strokes, and some kinds of blindness. The problem physicians face is to break up the log jams – dissolve the clots.

Dr. Sol Sherry of Washington University Medical School, in St. Louis, thinks he has an answer. He has tried, with some success, a method that uses the body's own natural defenses against internal clots. From human urine, Dr. Sherry has extracted an enzyme called urokinase. (An enzyme is a substance that helps speed up and control chemical reactions that go on in living things.) Urokinase is an enzyme that works specifically on blood clots to dissolve them.

Next spring, urokinase will undergo extensive trials with patients at research hospitals across the country. Dr. Sherry, as well as the U.S. Public Health Service's National Heart Institute, which is coordinating the study, will be watching the results carefully.

New Hope for Accident Victims

A new operating technique may make it possible for persons who are paralyzed from the shoulders down to regain the use of their limbs. A 73-year-old Canadian surgeon reports that he has successfully mended the spinal cord of a man who was almost totally paralyzed in an accident five years ago.

Of his patient, Dr. Gordon Murray said, "He hasn't moved a joint for three years. Now this fellow is going to walk."

Dr. Murray has been honored for his work in open heart surgery and in the development of an artificial kidney. In the new operation, Dr. Murray cut through the patient's spinal cord and removed the damaged portion. Dr. Murray then shortened the bone surrounding the cord. The two cut ends of the spinal cord were spliced together. Surgeons used special tools to bore holes through the bones so that they could be reconnected with wire.

Some scientists doubt that Dr. Murray has indeed been successful in his revolutionary attempts to restore nerve function. Others have enthusiastically congratulated him.

In Cleveland, a physician said, "If indeed the cord had been completely severed and then rejoined, it would be an accomplishment totally unheard of in medical history."

A University of Chicago expert in neurosurgery said that the operation, if successful, would be a dramatic breakthrough in medical history. He added that doctors have been blocked for years in their efforts to repair nerves that have lost their ability to function.

Columbus Day for Nuclear Energy

On December 2, scientists celebrated the 25th anniversary of their own version of "Columbus Day."

On that date in 1942, in Chicago, an Italian physicist named Enrico Fermi opened the path to a new scientific world – the harnessing of nuclear energy. At exactly 3:25 p.m., Fermi directed scientist George Weil to remove the control rod of the first successful atomic pile (a pile of bricks that encloses uranium). Seconds later, Fermi and a small group of scientists knew that they had set off the first controlled self-sustaining nuclear chain reaction.

Three years before Fermi's success, scientists had learned that atoms of the chemical element uranium-235 split when they were struck by tiny atomic particles called neutrons. In the process, additional neutrons were released. These, in turn, could be used to split other uranium-235 atoms, releasing energy. If enough uranium was present, they theorized, this reaction would continue under its own "steam." The

Wide World photos

Bertram Proulx, who was paralyzed for three years, demonstrates the success of a new spinal cord operation. Proulx can now sit up and stand unaided, and he can walk with help.

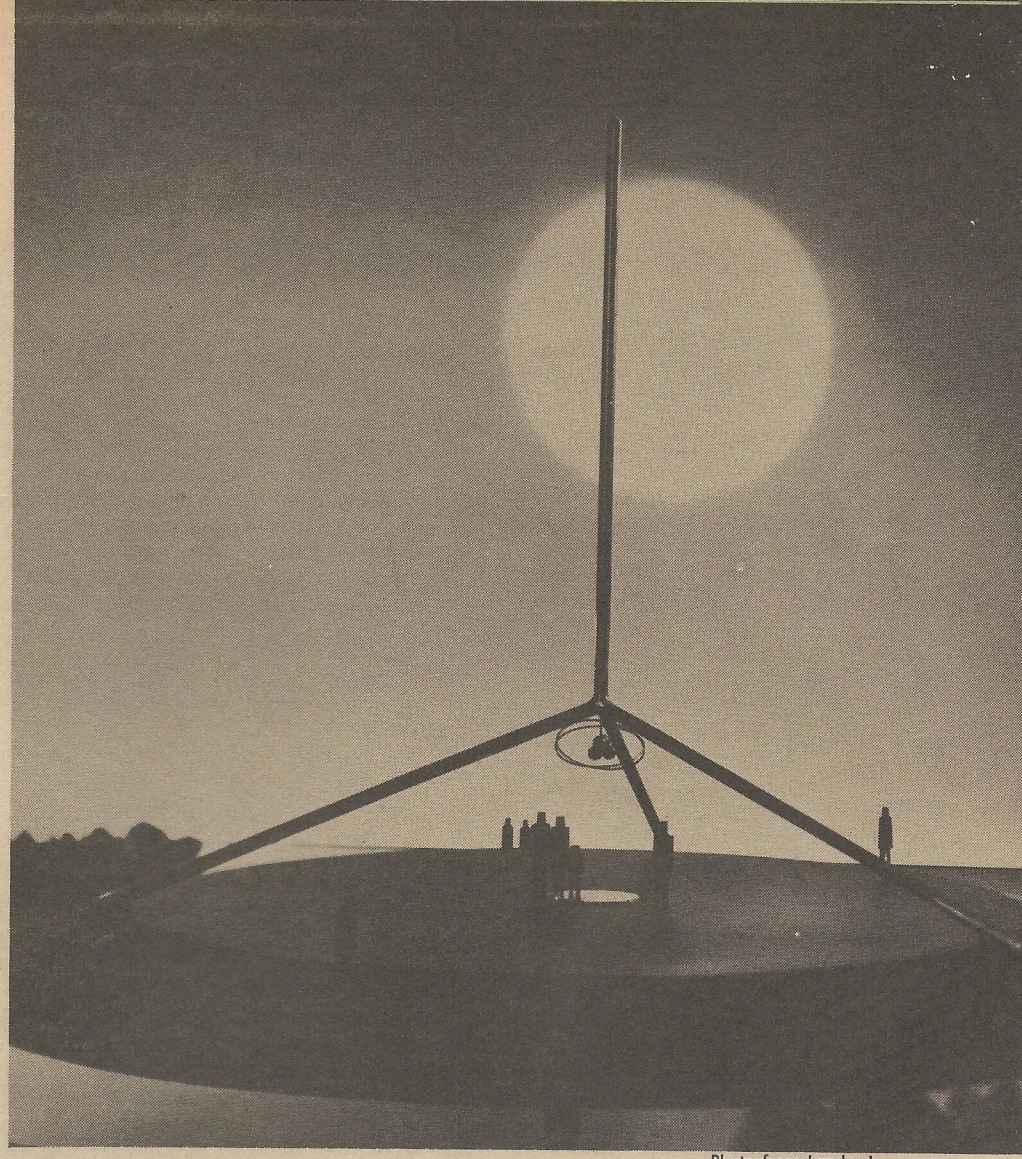


Photo from Lando, Inc.

Photo shows model of Helium Centennial Time Columns, monument soon to be erected in Amarillo, Texas, to commemorate 100th anniversary of discovery of helium on the sun. Each column will hold helium and items showing our need for natural resources.

December 2 experiment proved the theory correct and ushered in the Atomic Age.

The experiment was conducted with great secrecy, and one of the scientists reported the results as follows: "The Italian navigator has landed in the New World, and the natives are friendly."

News Briefs

▸ Project Stratoscope—a telescope-toting balloon that has been grounded for three years—may be in operation again next April. Plans call for the floating of a 36-inch telescope 80,000 feet above Earth's surface to photograph Jupiter and a distant star-producing gas cloud.

▸ A 142-mile stretch of the Missouri River has been tested for water pollution with a new, bright red, fluorescent dye. Scientists from the U.S. Geological Survey are using the harmless new dye to find out how pollutants travel through the river's waters.

Omega Watch Co. photo

This Colt .38 has been bridled by time-conscious engineers. It will be starting pistol used at Olympics in Mexico City next year. Pistol is wired to electronically operated cameras and timers at finish line. When fired, it will start timers and cameras.

Photo from California Institute of Technology

Dr. Wheeler North
He Explores Undersea Forests

CAL TECH'S Dr. Wheeler North is a professor of environmental engineering who doubles as a forest ranger. For a forest ranger, he wears a rather strange uniform: a scuba diving tank, a rubber wet-suit, and a face mask. Dr. North takes care of forests beneath the sea!

These submarine forests flourish off the coast of southern California. They consist of marine plants called *Macrocystis pyrifera* (giant brown kelp). This seaweed can grow as fast as two feet a day, and reaches 200-foot lengths. It is one of the fastest-growing plants in the world.

On a beach, kelp, like other seaweed, is a lumpy, flea-ridden nuisance. But in the sea, it rises proudly from a bottom anchorage of root-like "holdfast." Long, vine-like fronds extend up towards the sunlit sea surface. At the surface, the fronds spread over the water to form a thick brown canopy. Long leaf-like "blades" extend like streamers from the fronds. The blades filter out microscopic nutrients from the rich sea solution

Photo from Barry Herron

Dr. North inspects a tank filled with tiny kelp plants growing on rope. The ropes will be used to start new forests of kelp.

Scores of prickly sea urchins strip California kelp plants bare. Until controlled, the sea urchins threatened the kelp beds.

to nourish the kelp's speedy growth.

At the base of the blade is a small, bulb-like formation. On the beach, you can make a sharp popping noise by pinching these bulbs. Hollow inside, they help buoy up the rangy, 300-pound kelp plant.

Kelp plants grow six feet apart; a sea forest of kelp plants can cover eight square miles. No leaves rustle in this forest, and no limbs creak. The kelp plants sway gently and silently to the beat of waves rushing to the shore. Since kelp will grow in waters no deeper than 100 feet, forests exist close to the shoreline, often just beyond the surf-line.

As a boy, Dr. North enjoyed diving into these kelp forests. Your first dive into kelp can be somewhat unsettling. The swaying kelp fronds seem about to reach out and quietly ensnare you, reminding you uncomfortably of the arms of an octopus.

But then you see fish of all sizes and colors nonchalantly glide through openings in the brown foliage, and soon you are doing the same. The canopy above sieves the light into beams, and these beams burnish the kelp in green, amber, and golden hues. A plump bass swims by with a perch wriggling in its jaws. Schools of tiny smelt flit by. What appears to be a flame may also dart past. The moving flame is a garibaldi, the goldfish of the kelp forests.

Dives in the kelp forests inspired in Dr. North a great interest in marine biology. In 1958, he was doing post-graduate work at Scripps Institution of Oceanography at La Jolla, California. During this time there was a mysterious recession in some kelp forests. They were gradually shriveling up into ghost forests, bereft of all but an occasional frond or stray bass.

This recession perturbed the California Department of Fish and Game. Kelp forests shelter and sustain vast communities of fish and shellfish valuable to commercial and sport fishermen. They are a prime recreational resource for skin divers. The forests are also harvested by boats equipped with sea-going reapers. The kelp harvest is processed into fertilizers and vitamin supplements. Moreover, kelp contains a valuable chemical substance that gives the plant the tensile strength to resist the constant tug of the waves. This substance is refined into algin, a chemical "fastener" that holds together ice cream and many synthetic products. All these were threatened by the recession in kelp forest growth. Result? Dr. North was appointed to head a scientific investigation into the kelp decline.

Threat of the "Purple Pincushions"

Studying a kelp plant, Dr. North soon found out, is like "studying a redwood tree." Seven days are required to lay out a kelp plant on the beach and study, measure, and analyze it. Some people claimed kelp harvesting was responsible for the kelp decline. But Dr. North and his investigators found that a kelp forest can be harvested three or four times a year, and that harvesters may cut to a depth of four feet. Indeed, the cutting acts as a pruning device that stimulates kelp growth.

The kelp decline was most serious off coastal cities. This led to suspicions that sewage outfalls might harm kelp forests. These huge pipes spew sewage into the sea, for disposal. On his dives into dying forests, Dr. North found his vision clouded by suspended sewage particles. But laboratory tests showed that kelp can flourish in sewage water. Such water can actually act as a fertilizer.

As the kelp decline became more perplexing, a solution became more critical. An abnormal rise in ocean temperatures severely limited kelp growth, and further added to the kelp decline. On one underwater inspection, Dr. North finally uncovered a clue, in the form of a creature that resembles a purple pincushion. The creature is a sea urchin, and the "pins" are spines that can puncture a man's flesh. Equipped with tiny teeth, urchins graze on kelp holdfast. Normally, they move on to greener (or browner) pastures, thereby allowing the kelp to regenerate. But Dr. North found millions of urchins remaining stationary in a dying kelp forest. It was as if a thousand cattle were grazing an acre of alfalfa.

Dr. North decided to try to exterminate the urchins in the dying forests. But how? Fur hunters had long since purged the urchin's major predator, the sea otter. The French control sea urchin populations by eating them, but few Americans are prepared for this approach. Fencing off urchins from kelp forests is ineffective; they can climb on tube-like feet.

One day, Dr. North and a squad of scuba divers, armed with hammers, invaded an urchin-infested kelp forest. They soon surfaced with spines in their hands and few squashed urchins to their

Continued on next page

Today's Scientists *continued*

credit. Then Dr. North learned that quicklime was used to kill starfish gorging on oyster beds. In the laboratory, quicklime proved just as effective on urchins, without affecting fish or kelp.

A quicklime treatment in one forest killed many urchins, and soon young kelp plants began wriggling upwards. But then the plants disappeared. Urchins have a sense of smell, and the scent of juicy new kelp apparently attracted them from nearby areas. Dr. North decided to treat a larger area with quicklime. This time, advancing urchins stopped at the edge of the treated forest. A relieved Dr. North concluded that bottom drift kelp from the treated forest met the food needs of the urchins. Bass, garibaldi, and skin divers once more had a home.

With the quicklime treatment, Dr. North has revived a forest off San Diego, and is now reviving another forest off Los Angeles. Dr. North has also learned how to transplant kelp plants to barren seabeds to spawn new forests.

Underwater Forest Rangers

Plants are severed from an existing forest and towed into an area that has a rock reef. (Sand bottoms are not suitable, because the kelp holdfast can grip only rocks.) The plants that are towed in are not set on the rock reef. Instead, they are buoyed above the rocks to release germinating spores. These spores settle on the rocks and grow into kelp plants. Because fish graze heavily on isolated strands of kelp, approximately 100 plants have to be towed in and buoyed.

This transplanting capability may become very important in the future. Although common in the Southern Hemisphere, in the Northern Hemisphere, giant brown kelp exists only off our Pacific coast. Future sea rangers may be able to transplant kelp to other coastlines.

Meanwhile, an ominous aspect of the sea urchin sit-in at the kelp forests is appearing. Current tests sponsored by the U.S. Public Health Service and conducted by Dr. North show that urchins can subsist on small plants nourished by sewage. Dr. North now feels that this source of nourishment may encourage urchins to remain near sewage outfalls and prevent kelp in the area from regenerating.

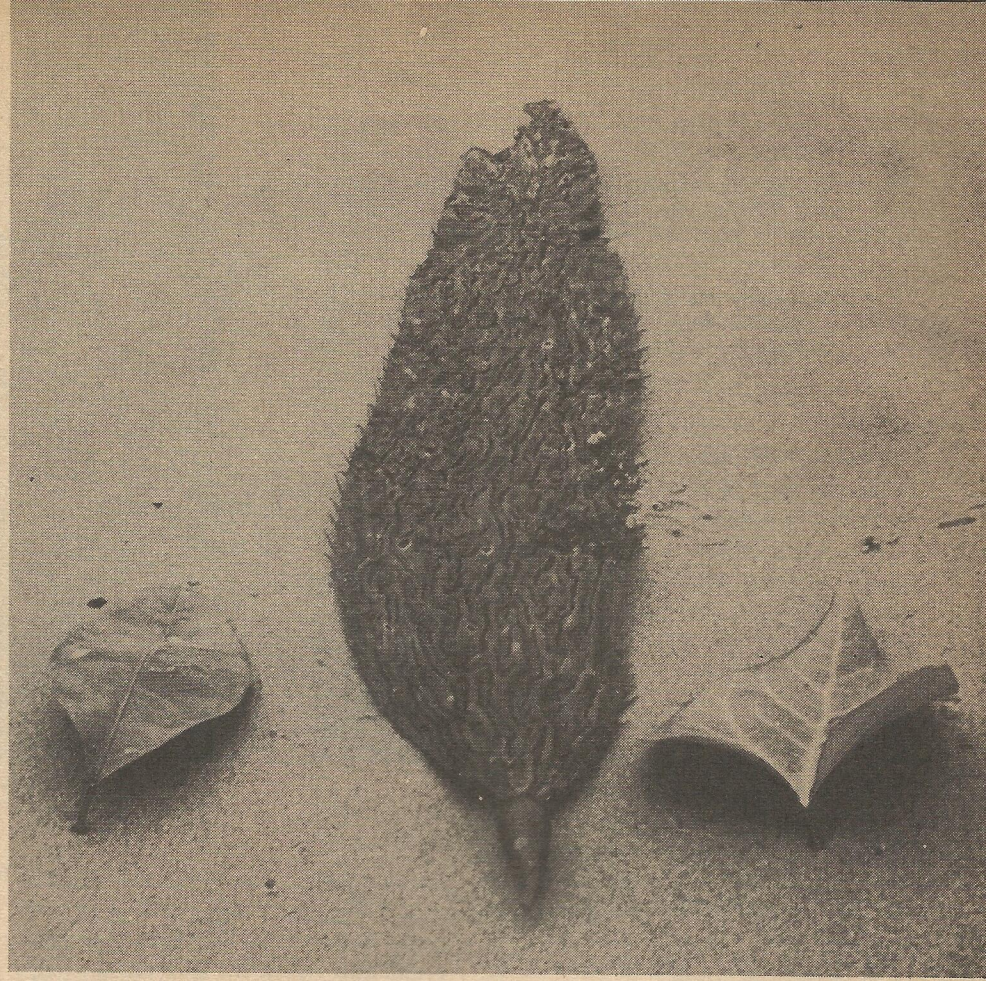


Photo from Wesley Marx

Kelp blade is compared with ivy leaf at right and citrus leaf at left. The blade filters nutrients from sea to provide for growth of the 300-pound, 200-foot plant.

The construction of many coastal atomic power plants may present another problem. Sea water used to cool plant reactors is returned to the ocean. These large discharges may raise offshore ocean temperatures to a point that threatens the kelp's survival. In cooperation with one atomic power project, Dr. North is studying the use of temperature-resistant kelp from Mexico.

Frequent dives into kelp forests have provided Dr. North with some disquieting experiences. One day, a sleek blue shark appeared. "It began investigating me," recalls Dr. North. "Its snout even bumped into my camera." But the shark disappeared as casually as it had arrived. Another day, Dr. North's air supply waned and he started towards the surface. A wave surge arose, and suddenly the professor was pinned in the middle of the sea. A line from a buoy had looped around his air tank controls. Another wave surge miraculously untangled him, and Dr. North escaped an underwater hanging.

Such experiences have not dampened Dr. North's enthusiasm for kelp forests. Even when not working, Dr. North enjoys cruising through kelp fronds, and trailing garibaldi. "I've explored coral reefs off Hawaii and Mexico and found them interesting. But they don't have the fascination of kelp forests. I go down and start seeing what's going on, and soon I'm all wrapped up in the forest." Dr. North foresees the day when a trained corps of California sea rangers will lime urchins, stake out nature trails, save people with empty air tanks, and unsnarl weekend submarine jams. Unlike their counterparts on land, these rangers won't have to worry about people who drop lighted cigarettes. But they may have to post signs that read, "Don't feed the sea urchins."

Not all people share Dr. North's concern for kelp. "Once, while I was docking, a game warden asked if I had caught anything. I pointed to the deck of my boat, littered with kelp specimens. The warden started to laugh but then he mustered a sympathetic smile and said, 'That's wonderful. Hope you keep on having such good luck.' He started to walk away but then added, 'Have you ever tried the beach?' "

— Wesley Marx

PROJECT POINTERS

The Photodynamic Effect

THE STORY on the ecology of poisons (see pages 4-8) may interest you in investigating a type of toxic reaction known as the photodynamic effect. This reaction, which occurs when protozoans that have ingested any of certain dyes or chemicals are exposed to light, can kill the organism or shorten its life.

You can carry out many projects on the photodynamic effect. You might begin by studying the effects of varying the length of exposure to light, as well as the effects of using different kinds of light.

Start your work with common dyes, such as methylene blue, eosin, and fluorescein. Then use other chemicals or materials — for example, ergosterol (the vitamin D factor) and cholesterol (the crystalline, fatty substance probably involved in hardening of the arteries). You may want to discover what other stains and dyes exhibit the photodynamic effect. The main requirement is that *the chemical itself must not kill the organism.*

Paramecia is probably the easiest protozoan to use as your experimental subject. Later, you may want to try other protozoans. Cultures of paramecia (and other protozoans) may be obtained from a biological supply house, or collected from a fish tank. Remember to reserve part of the culture for setting up proper controls, including groups that receive the chemical, but no light.

To prepare for your experiments, add a few drops of one of the photodynamic agents to a slideful of the experimental paramecia (or other protozoans). Use a microscope to observe the ingestion of the dye or other agent. Watch the dye being moved by the cilia down the gullet and into the interior of the paramecium.

When you have observed a good concentration of the dye in the vacuoles of the paramecia, you are ready to begin your first experiment with the photodynamic effect. Expose the protozoans to a very bright light for about one second, or even less. Repeat this process until the paramecia on the slide die.

Next, give other groups of paramecia different, lower exposures (by giving smaller numbers of individual exposures). Observe the differing impact of the photodynamic effect on the lifespans of the paramecia receiving the various exposures.

Compare the photodynamic effect brought about by fluorescent lamps with that produced by an ordinary incandescent light bulb. What happens if ultraviolet (uv) light is used? A sun lamp can provide your ultraviolet light if you don't have a special uv source.

WARNING: *Ultraviolet is dangerous.* Protect your eyes with goggles made especially for use with sun lamps. Even when wearing goggles (sold in drugstores), never look directly at the sun lamp or other uv source.

A device for achieving precise control of the exposure to ultraviolet (or other) light is easy to make. Start with an old camera that has an adjustable shutter in working condition. Leaving the shutter in place, remove the lens element(s) and the camera back. If there is an iris diaphragm, open it wide.

Attach the camera to a ringstand by rigging a clamp that screws into the camera's tripod thread. Place the ultraviolet source (or other light) at the open camera back. Provide a cover to shield your eyes from uv.

To use your controlled-exposure device, place the slide bearing the protozoans on the base of the ringstand. Set the shutter for the exposure length desired (1 sec, 1/5 sec, 1/25 sec, 1/100 sec, etc.). Then trip the shutter as many times as your experimental program calls for.

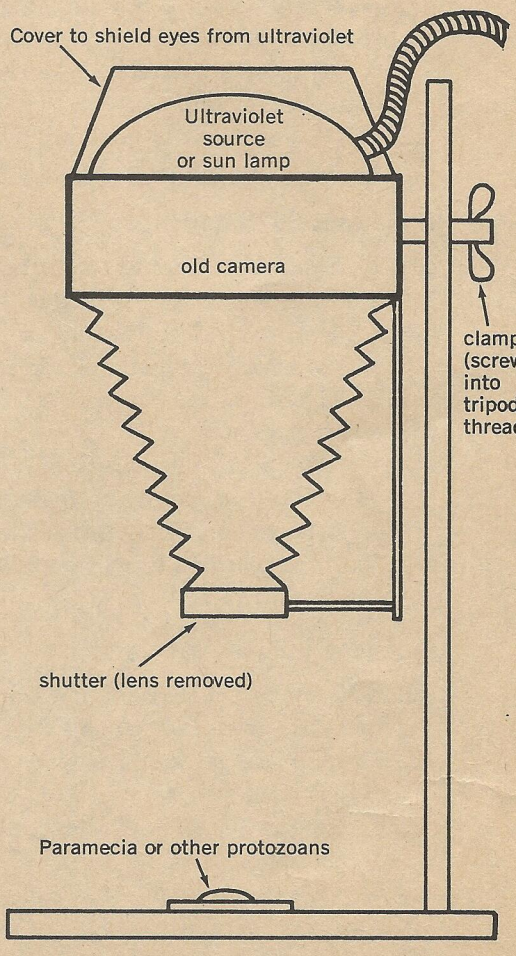
The photodynamic effect was discovered in 1900. Its cause is believed to be the diversion of oxygen brought about by the light flash. That is, some oxygen is lost to the paramecia when the oxygen activates the dye during the flash. Keep this explanation in mind as you perform the following investigations:

Place the paramecia in cooled pond water that has been boiled. The boiling will drive out dissolved oxygen from the water. Does the low oxygen level in the pond water affect the photodynamic effect?

Next, raise the carbon dioxide level by adding club soda to the water. How does a strong carbon dioxide environment affect the photodynamic effect?

Finally, you can try the combination of low oxygen level and high carbon dioxide level by bubbling carbon dioxide through cooled, boiled pond water. Use a carbon dioxide generator that employs vinegar and sodium bicarbonate. Or, simply add a tiny piece of dry ice (solid carbon dioxide).

— ALEXANDER JOSEPH


Cover to shield eyes from ultraviolet
Ultraviolet source or sun lamp
old camera
clamp (screws into tripod thread)
shutter (lens removed)
Paramecia or other protozoans

Exposure Device for Photodynamic Effect

SCOREBOARD

How well have you read your *Senior Science*? Answers to questions with no asterisks may be gleaned directly from the articles. Answers to questions with an asterisk (*) require fusing the facts in the articles with those learned in the classroom or from your reading. Answers are in the SCOREKEEPER on page 20.

I. The Deep Freeze

____1. Just as there is a temperature below which we cannot go, scientists believe there is also an upper limit to the temperature scale.
____2. Two objects at the same temperature always contain the same amount of heat.
____3. A temperature of 0°C is equivalent to 273°K.
____4. 273 cubic centimeters of a gas at 0°C will contract to occupy 272 cubic centimeters at −1°C.
____5. Scientists have succeeded in producing temperatures within a few millionths of a degree of absolute zero.
____6. Hydrogen solidifies at a lower temperature than does helium.
____*7. A gas at 40°C contains twice as much heat as the same volume of gas at 20°C.

II. Poisons in Nature

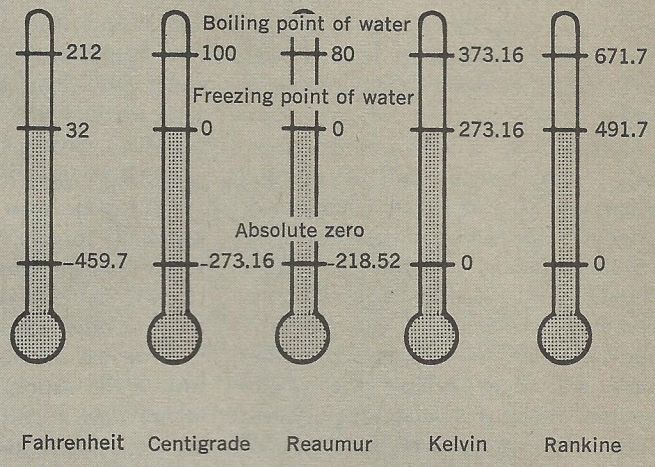
____1. Evidence indicates that the tarantula spider has exceptionally keen eyesight.
____2. The survival of the digger wasp, *Pepsis,* depends on the existence of the tarantula spider.
____3. The digger wasp is herbivorous in all stages of its development.
____4. A millipede, which itself produces the highly poisonous gas hydrogen cyanide, can live in an atmosphere containing this gas.
____*5. One scorpion cannot be killed by the sting of another scorpion.

III. Today's Scientists

____1. Some varieties of marine kelp can grow at the rate of as much as two feet a day.
____2. Kelp can be found in even the deepest parts of the ocean.
____3. Kelp is a commercial source of several important vitamins.
____4. Kelp is in danger of becoming extinct, largely because of overharvesting.
____5. The sole diet of sea urchins is kelp.
____6. Kelp can flourish in sewage water.

Going Beyond

The Kelvin scale is but one of a variety of temperature scales in use throughout the world. How much do you know about temperature and its measurement? Try your hand at answering these questions after studying the temperature scales shown.



1. To determine a temperature scale, it is first necessary to set two fixed points on which the scale can be based. What are the fixed points on the Centigrade scale?
2. What are the fixed points on the Fahrenheit scale? (Hint: they are *not* 32° and 100°).
3. How did Gabriel Fahrenheit determine the fixed points on his thermometer? (If you dig out the answer to this one you're in for a surprise.)
4. The Reaumur scale was constructed on the principle of taking the freezing point of water as 0° and graduating the tube of the thermometer into degrees, each of which was one thousandth of the volume contained in the bulb and tube up to the zero mark. In what way was the setting of the Reaumur scale different from that of the Fahrenheit or Centigrade?
5. The Rankine scale is an absolute scale similar to the Kelvin scale. How was the Rankine scale arrived at? (Hint: the Rankine scale is to the Fahrenheit scale what the Kelvin scale is to the Centigrade.)

ANSWERS ON PAGE 2

brainteasers

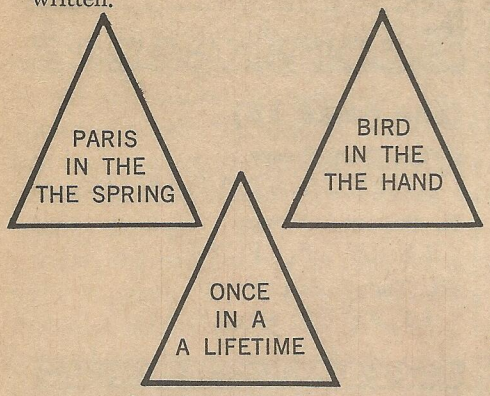
Short Cutting

If it takes one minute to make one cut, how long will it take to cut a twelve-foot pole into eight-inch sections?

Jeff Caplitz
Churchill Jr. H. S.
Muskegon, Mich.

Read Aloud

Look at the phrases in the triangles. Then read the phrases aloud as they are written.



A test has shown that only one out of forty adults can read the phrases accurately. How did you make out?

Sharon Prager
Milwaukee, Wis.

Current Problem

A boatman, rowing upstream, noticed a log as it floated past him. He continued upstream for half an hour longer, and then turned and rowed downstream. He stroked his oars at a steady rate, always exerting the same pressure on the oars. When he overtook the log, he observed that it had floated exactly one mile downstream from the point where he first passed it. How fast was the stream's current?

Carol Olsen
C. R. Anderson School
Helena, Mont.

Do you have a favorite brain teaser? Send it to Senior Science, 50 West 44th St., New York, New York 10036. We will pay five dollars for each one published. Include the name of your school, home address, grade, and age. In case of duplicate submissions, choice will be made on the basis of presentation and clarity.

Editor's Choice

If you walk two miles uphill at a rate of two miles an hour, and you walk two miles downhill at a rate of six miles an hour, what is your average speed for the four-mile trip?

Editor's Error

Hundreds of readers have politely called to our attention an error in the solution to "Frog Food" which appeared in the October 12 issue. The correct solution is a consumption of 20 flies — more than enough for any frog to digest.

LET YOUR GREETINGS HELP A CHILD

Greeting Cards sold for the benefit of UNICEF, the Nobel Peace Prize-winning United Nations Children's Fund, mean help and hope for needy children in over 100 countries. Offered are 20 lovely designs by leading artists from 12 nations—messages of happiness which express the cheer and joy of the year's most festive season. Order a free full color brochure from UNICEF, P.O. Box 22, Church St. Station, New York 10008.

Science on TV

Tomorrow's World

(Fri., Jan. 5, 10:00 p.m. EST, NBC-TV)

A series of four hour-long science specials begins with a look at U.S. efforts in outer space and an examination of the future in space as it can be predicted by scientists today. Animation and special visual effects will be used to show how man will explore his own galaxy and gain scientific data on other galaxies in the universe.

Other programs in the series, as yet unscheduled, will include special reports on inner space and food production.

Animal Secrets

(Sun., Jan. 7, 5:00 p.m. EST, NBC-TV)

Dr. Loren Eiseley, professor of Anthropology and History of Science at the University of Pennsylvania, returns as host for the second season of this series which last year won the Thomas Alva Edison Foundation award for the best science TV program for young people. The series was originally intended for children, but by the end of last season, it had attracted an equally large number of adult viewers.

Subjects are covered in concise, easy-to-understand terms. Among the subjects covered this season will be a look at how life began, a report on new discoveries about learning and memory, and an examination of what a brain is and how it works.

The Undersea World of Jacques-Yves Cousteau

(Mon., Jan. 8, 7:30 p.m. EST, ABC-TV)

A new undersea expedition by Captain Jacques-Yves Cousteau, French oceanographer and underwater explorer, has been recorded for television and will be shown by ABC-TV in a series of at least 12 hour-long specials. For the past year, Cousteau and a crew of 29 have been exploring the world's oceans in a 400-ton vessel called the *Calypso*. In the opening program, the men are shown tracking down man-killers of the sea in a effort to find ways to protect downed flyers against sharks.

The *Calypso* carried an arsenal of undersea equipment, including revolutionary Aqua-Lung packs, highly advanced underwater color cameras, diving scooters, and an underwater house in which the men lived and worked under the sea.

— Peggy Hudson

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ANSWERS TO PUZZLE

(see page 2)

P	R	I	S	M	S		E	D	I	S	O	N
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SENIOR SCIENCE 12.14.67

Scorekeeper

(see page 18)

I. The Deep Freeze
1.F; 2.F; 3.T; 4.T; 5.T; 6.F; *7.F.

II. Poisons in Nature
1.F; 2.T; 3.F; 4.F; *5.F.

III. Today's Scientists
1.T; 2.F; 3.T; 4.F; 5.F; 6.T.

Senior Science
Wishes Its Readers
a
Merry Christmas
and a
Happy New Year

help us help

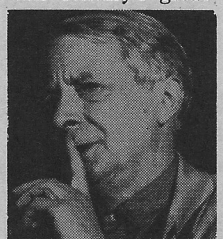
DISC-USSIONS

THE BEST OF THE NEW LPs

BY ROY HEMMING
with Robin McBride, Ed Coach, Buzz Royden

CLASSICAL ALBUM OF THE WEEK **Lutoslawski: Concerto for Orchestra; Venetian Games; & Funeral Music—Warsaw Philharmonic, Rowicki** [*Philips PHS-900-159*]. The European edition of this LP has already won the Grand Prix du Disque (awarded by the Académie Française)—and it is justly deserved. Witold Lutoslawski, now 54, has ranked as postwar Poland's foremost composer for many years, yet this is the first major U. S. release of his music (a short, early two-piano work was released as part of *London CS-5443* in 1965). Why the splendid, folk-inspired *Concerto for Orchestra* (1954) should have had to wait so long for a recording is hard to understand. Ever since I heard its U. S. premiere in 1959 (by the New York Philharmonic under Skrowaczewski), I've felt that it ranks close to Bartok's *Concerto for Orchestra* as a first-rate modern score that intrigues and dazzles both for the inventiveness of its musical ideas (including some most melodious ones) and the brilliance of its orchestration (it really provides a workout for a modern orchestra). The two works overside are more "advanced" scores, utilizing 12-tone and aleatoric (partly improvised) concepts. Though of less general appeal than the *Concerto*, they are both significant works of their kind—and deserve a thoughtful hearing by anyone interested in the future of orchestral music. Rowicki's performances and the sound engineering are all first-rate. (R.H.)

BUDGET ALBUM OF THE WEEK **Ravel: Daphnis and Chloe (Suites No. 1 & 2)—Charles Munch, Boston Symphony, New England Conservatory Chorus** [*RCA Victrola VICS1271*]. Ravel's 1912 ballet score remains one of this century's greatest, and few conductors have ever projected its elegance and glittering fireworks so dazzlingly as Munch. His 1955 recording of the complete score was "retired" when he re-recorded it in new stereo techniques in 1962. Now RCA has cleverly taken those sections from the 1955 version that conform to the two suites Ravel arranged from the ballet—and combined them in this outstanding budget release. The performance is still superb, and so is the sound engineering. Though the newer '62 version [on *RCA Victor LSC2568*] is admittedly superior (*and* complete), this reissue clearly outdistances any other version of the *Daphnis* suites, and is the only budget edition to include the choral sections. Once you've heard this music *with* the chorus, the orchestral-only versions just don't sound as exciting. (R.H.)



Munch—"still superb"

Mendelssohn: Concerto for Piano & Strings (& Other Works)—Rena Kyriakou, Vienna Symphony [*Vox Turnabout TV3417OS*]. Surprising as it may seem, this is a "world premiere" recording. Although several Mendelssohn concertos have long been concert hall staples, this one was only recently rediscovered. Either an early work or an unpolished later one (music scholars are divided), it is a deftly melodious and amiable score, though hardly a great one. Miss Kyriakou, the Cretan pianist who has made a specialty of Mendelssohn's piano music, makes a most persuasive case for its "restrained romanticism"—as well as for the *Serenade & Allegro Gioioso* (Op. 43) and *Rondo Brillante* (Op. 29) which complete the disc. Especially recommended for "conservative" piano lovers tired of familiar warhorses. (R.H.)

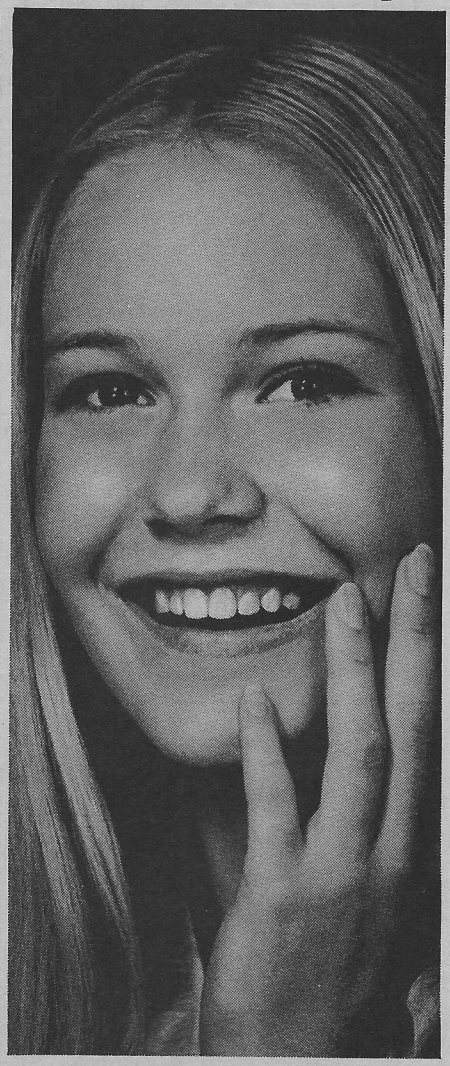
POPULAR ALBUM OF THE WEEK **Anything Goes—Harper's Bizarre** [*Warner Bros. WS1716*]. Couched in the framework of early radio "live" ballroom broadcasts, this disc is a supergreat combination of fun, camp, and pop sounds. Using a well-arranged, fully orchestrated pop approach, the group breathes fresh air into standards ("Milord," "Chattanooga Choo Choo," the title tune) and new material ("The Biggest Night of Her Life," "Hey, You in the Crowd"). The boys are anything but "bizarre," and are a tremendous lift to today's pop scene. (R.M.)

Winds of Change—Eric Burdon and The Animals [*MGM SE4484*]. This is a most unusual album. Although some of the cuts are "tunes," most of the selections are recitations with rock music. It's a very different approach, and from a performance standpoint excellently done. Eric's messages are clear, though sometimes the quality of the lyric (or poem) is lacking. For all its weaknesses, however, this album should be heard, especially "Paint It Black," "The Black Plague," and "San Franciscan Nights." The musical (and electronic) effects are sometimes startling, but always appropriate. (R.M.)

Strange Days—The Doors [*Elektra EKS-74014*]. In their second album The Doors continue to demonstrate that large orchestras and superelectronicism are not necessary for good (or unusual) sounds. Instead, Jim Morrison has developed a whispering, raspy-smooth vocal style that fits perfectly with the hypnotic, melodic monotony of this group's performance. Although you won't hear it on their biggest hit singles (such as "People Are Strange," included here), this group also excels in the art of the beautifully built instrumental solo, and this LP has many. (R.M.)

A Kind of Hush—John Davidson [*Columbia CS9534*]. John has already shown us in earlier albums how well he can use his big, strong voice in pop and show ballads. Now he shows how equally well he can sustain an entire "soft lights" album, singing quietly and intimately with guitar and small combo backing (the title tune, "Today," "Feelin' Groovy," etc.). Few youthful pop crooners could pull it off as perfectly as John does. (B.R.)

Look! Clearer skin from a soap



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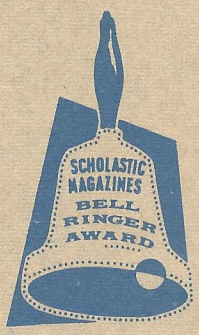
FOLLOWING THE FILMS

CAMELOT
(Warner Bros.-Seven Arts)

"As long as you live," says Arthur (Richard Harris), King of Britain, "you will remember what I, the King, tell you."

Arthur's story is also the story of the rise and fall of Camelot. It is one of the most durable legends in English literature. Now it has come to glittering life in this film version of the stage success by Alan Jay Lerner and Frederick Loewe.



When *Camelot* begins, Arthur is about to lead his forces against Lancelot, his former friend. A boy (Gary Marsh) approaches the King and offers to follow him into battle. But Arthur sends him away, so that he may live to tell the world "of the fleeting wisp of glory called Camelot."

What was Camelot? The film tells us it was the place where Arthur held court, but it stood for even more than that. After winning his kingdom, Arthur made Camelot a place of honor, dignity, and beauty. Under his leadership, peace became fashionable. Knights flocked to join his Round Table, and help him fight for decency and goodness.

The bravest and strongest of these knights was Lancelot (Franco Nero). But he proved to be the weakest link in Arthur's attempt to forge a new Golden Age for Britain, when he fell in love with Arthur's wife, Queen Guenevere (Venessa Redgrave).

Mordred (David Hemmings), Arthur's evil son, used Lancelot's love for Guenevere to destroy Camelot. Stirred to frenzy by Mordred's gossip, the knights drove Lancelot away and forced the King to put Guenevere on trial. All the good Arthur had done was swept away. The knights wanted only revenge. The peaceful glory of Camelot was destroyed forever.

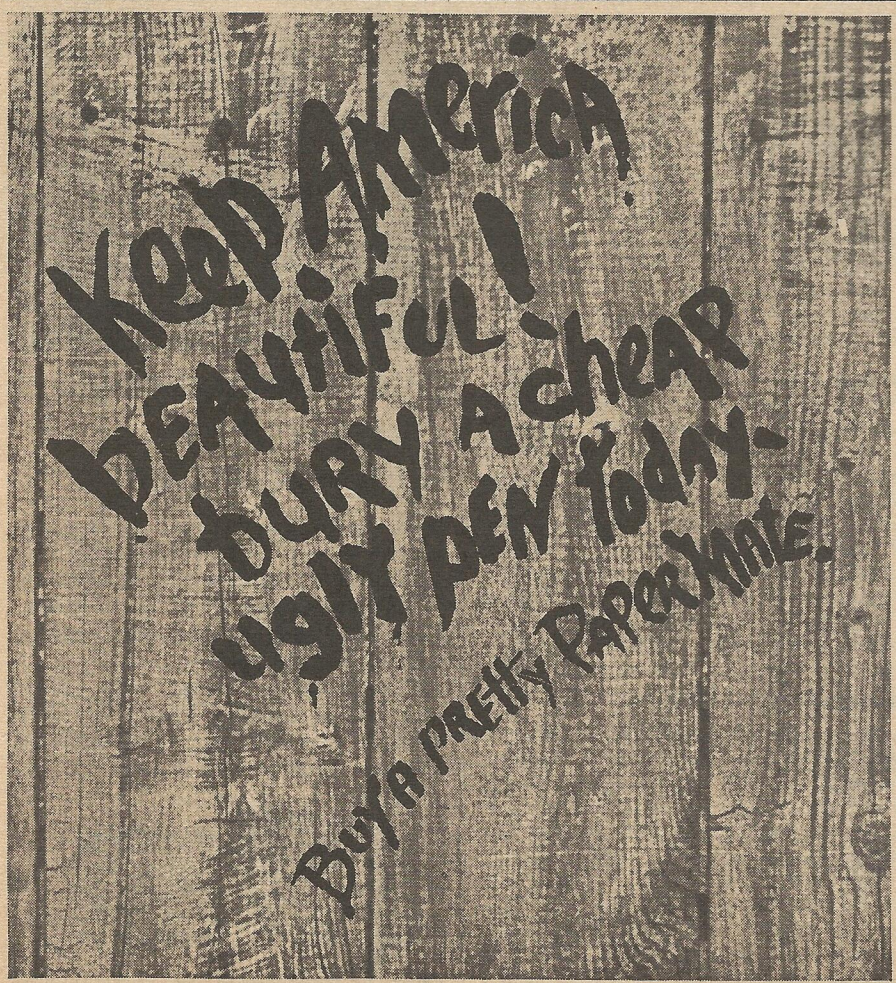
Richard Harris and Vanessa Redgrave are King Arthur and Guenevere in Camelot.

Although every moment of *Camelot* is a feast for the eyes and ears, it is more than just a sumptuous musical. The costumes and settings are magical enough to have been conjured up by Merlyn (Laurence Naismith), but they are only trappings. What really counts in *Camelot* is the wit and wisdom of the story, which says so much about human nature and the nature of human progress. If you are acquainted with the legends of the Round Table, you may feel that too much has been left out of *Camelot*. But this is the story of the three people who had the most to do with the rise and fall of Camelot itself. The film wisely concentrates on these three, and Vanessa Redgrave, Richard Harris, and Franco Nero play their parts with passionate conviction.

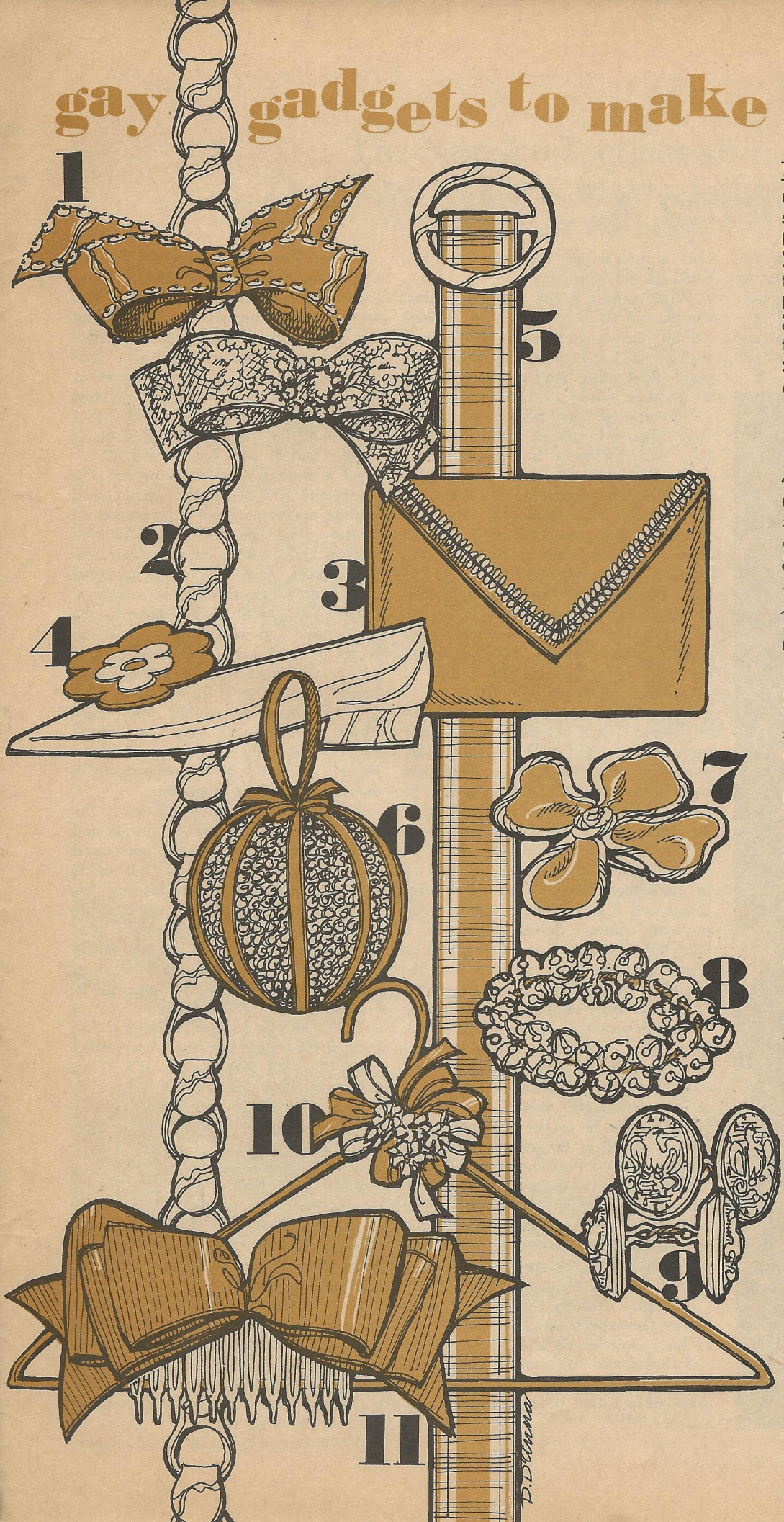
The lilting Lerner and Loewe melodies are woven like golden threads into the rich tapestry of *Camelot*. Except for the strangely cheery chorus that resounds as Guenevere goes to the stake, the songs seldom intrude on the action. The characters appear to be musing aloud rather than stopping to sing. In a magical place like Camelot, it seems quite natural that what they "say" should rhyme from time to time.

— MARGARET RONAN

Camelot has received the *Scholastic Magazines* Bell Ringer Award. These awards are given to motion pictures that meet *Scholastic Magazines'* standards of excellence in direction, acting, photography, and appropriateness of subject matter.



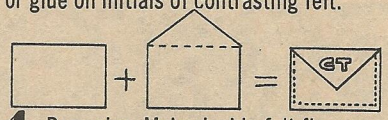
gay gadgets to make for giving



1. Holiday hairbows. Use 1½" wide ribbon or lace, tie it, tack it, and trim it by sewing on tiny pearls or sequins. Slip a bobby pin in the back.

2. Silvery chain belt. Make it with the ring tops you pop off soft drink cans. Bend the long tab over, hook it into a ring, and so on.

3. Felt mini bag. Cut one piece 6"x8", the other 6"x8" plus a triangular flap. Stitch together, add a snap, and sew on braid or glue on initials of contrasting felt.



4. Posy pins. Make double felt flowers (cut them out, glue them together) with safety pin backs to pin on a dress or a pair of silk shoes.

5. Hipster belt. Stitch a 30" length of striped grosgrain to belting, tack it around a round pearl belt buckle and hem the other end.

6. Pomander sachet. Stick an orange solidly full of cloves, tie it up with velvet ribbons to hang in her closet.

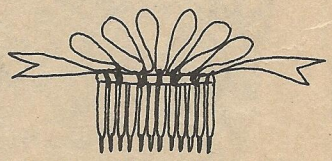
7. Papier mache pin. Mix one cup of instant starch with one cup of cold water. Dip five or more facial tissues into the starch, roll them into a ball, and pound them flat with a hammer on a piece of paper. Cut into a flower shape with scissors. Dip string in the starch and use it to outline the petals. When completely dry, paint it with bright tempera, glue on a clasp, and spray with clear plastic.

8. Jingle bracelet. String small silvery bells on an elastic cord and tie.

9. Cuff links. Look for four interesting buttons with loop backs about ½" in diameter. Tie in twos with elastic cord.

10. Happy hangups. Spray wire hangers bright pink, tie the tops with green and lilac ribbons, fake flowers, or little sachets. Make a set of six.

11. Gigi bow. Use a yard of 2" ribbon and a curved comb. Starting at the center of the ribbon, gather and tie it tightly with thread between the center teeth of the comb. Continue to gather and tie each four inches along the ribbon, using every other space on the comb.



Materials for making all these gifts may be found in a department store notions department (ribbon, belting, elastic, trims, buckles, buttons), dime store (bells, paint, fake flowers, comb), or your kitchen (starch, orange, cloves, pop tops.) Have fun!

SPORTS

The Sweetheart of Dayton Place

PEOPLE laughed when Dayton came out to play North Carolina in the semi-finals of the college championships last March. Sure, the Flyers had a 24-5 record. But they had barely squeezed by their three early-round foes, and their only star was a 6-4 forward named Don May.

What could a 6-4 forward do against the likes of the Tar Heels' L & M Boys (Bobby Lewis and Larry Miller) and 6-11 Rusty Clark? The Tar Heels, who were 26-4 going into the game, figured to be sure winners.

Sure enough, they rushed off to a 9-2 lead. Then everyone stopped laughing. Don May, without bothering to ask "May I?" took over the ball game. He began vacuum-cleaning the boards and shooting like Dan'l Boone in his prime.

Believe it or not, Don zipped in *13 shots in a row!* Some he shot from the corners. Others he sank on driving lay-ups. And a few he tipped in right over the head of 6-11 Rusty Clark.

It was awesome. Don put the whole North Carolina team in his hip pocket. He wound up with 34 points and 15 rebounds, as Dayton won, 76-62.

The next evening was, alas, a different story. UCLA simply had too many guns for the little Flyers. Still, May gave Lew Alcindor & Co. a battle. In fact he topped the scorers with 21 points and also pulled in 17 rebounds. As you'd expect, he was a unanimous choice for the all-tournament team.

That's the way Don has operated all his basketball life. He's a lot like Jerry Lucas and Bill Bradley: a quiet sort of guy who doesn't do anything with a flair, but who somehow finds a way to beat you. He keeps scoring and rebounding in a steady, dull fashion, until you suddenly realize he's killing you. As one opposing coach said, "May is a quiet killer. One way or another, he's always doing something to hurt you."

Don was the same sort of ball-player at Belmont High School in Dayton, Ohio. Though he set the city's one-game scoring record of 50 points, he usually worked quietly on the inside. On the outside and in the corners was a deadly 6-6 shooter named Bill Hosket, who went on to set an all-time city scoring record. The May-Hosket combo led Belmont to a 26-1 season capped by the Ohio Class AA championship.

Though Hosket was the flashier player, the experts rated May very close to him. Both made the all-state team and *Scholastic Magazines'* 1964 All-American H. S. Team. They were so great, in fact, that Belmont retired their numbers.

Hosket went on to star at Ohio State, while May chose to go to the university only two blocks from his house — Dayton. Some of the experts figured that Don, at 6-4, might be too small to play forward in big-time basketball. The Flyer coach, Don Donoher, laughed at their fears. "I never had the slightest doubt. You could tell in high school that May could hit the boards in any man's league, and he sure has proved it."

As a freshman, Don averaged 20.3 points and 19.6 rebounds a game. And he kept up the pace when he moved up to the varsity the next year. Though Dayton had a 7-foot All-American center in Hank Finkel, Don still managed to average 20.3 points and 12 rebounds.

Last year, with Finkel gone to the pros, May had to become the workhorse of the Flyers. This handicapped him in the sense that he had to work harder at both ends of the court. But it was a boon in another way. With Finkel on the court, May was limited as to where he could go. Without Finkel, he could go anywhere, which made him tougher to defense.

Despite the added work load, the 6-4, 215-pound package of muscle and coiled springs averaged 22.2 points and 16.7 rebounds per game. That made him the country's fifth leading rebounder. And get this: He was the only forward among the leading rebounders! Four skyscraping centers finished ahead of him, while the country's two best big men, Lew Alcindor and Elvin Hayes, finished behind him!

O. K., let's be honest: Alcindor didn't finish first because he always was pulled out of the game whenever UCLA ran up a big lead. Hayes didn't have to work the boards so hard, because Houston had several other big men to help him.

Still, you have to hand it to May. Nobody ever used 76 inches to such deadly effect under the boards. Now an All-American star, May is looking ahead to another great year. This time, however, nobody will be surprised at anything he does.

On the Dayton campus these days, it's May all year 'round. Don's mother works in the student union, while his kid brother, Ken, is starting another reign of May terror on the Freshman basketball team. There's no if, and, or May-be about his talent.

— HERMAN L. MASIN, *Sports Editor*

Not all of Bob's experiments work the first time. But sooner or later they do. He has a talent for chemistry. He puts in the time and the effort to be just as good as he can be in chemistry. And that's why we call him a GENIUS.

You know there are a lot of GENIUSES around. And you certainly can be one. You don't need a string of "A's" on your report card to be a GENIUS. You just have to make the most of the abilities you have.

We have all kinds of GENIUSES at General Electric who do all kinds of work. When you get out of school, we'll be looking for more GENIUSES — in science, engineering, English, mechanical drawing, stenography, foreign languages and industrial arts.

Remember everyone can be good at something; be a GENIUS at something. It's easy, if you try.

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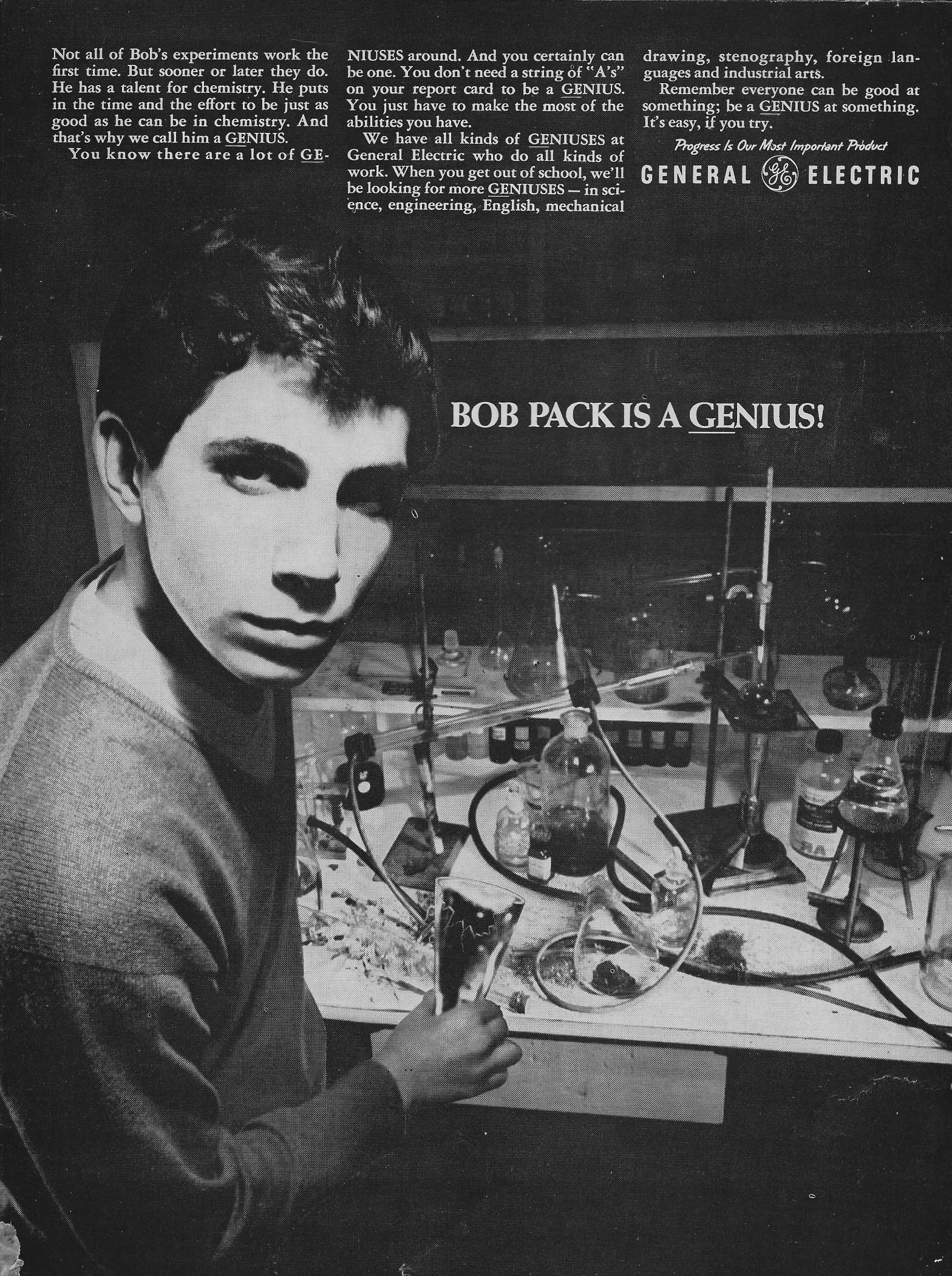

Join the Vitality Corps

Drink at least 3 glasses of milk every day

Three glasses of milk a day automatically makes you a member of the Vitality Corps. Milk gives you the vitality to get with the fun faster and stay with the fun longer. So join up today—drink milk for vitality!

a message from dairy farmer members of
american dairy association